Dean Pietro Belluschi  
School of Architecture and Planning  
Massachusetts Institute of Technology  
Cambridge, Massachusetts

Dear Dean Belluschi:

I am submitting herewith my thesis entitled "A Student-Faculty House for The Putney School, Putney, Vermont" in partial fulfillment of the requirements for the degree of Bachelor of Architecture from M. I. T.

Sincerely yours,

Signature redacted

John B. Rogers
A STUDENT-FACULTY HOUSE
FOR THE PUTNEY SCHOOL
PUTNEY, VERMONT

JOHN B. ROGERS

Submitted in partial fulfillment of the requirements for
the degree of Bachelor of Architecture on 18 January 1954

Signature redacted

Dean
School of Architecture and Planning
STUDENT-FACULTY HOUSE
PUTNEY SCHOOL
PUTNEY, VERMONT

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In this particular problem the background material is very important and I would like to begin its presentation with a description of the school which has been the client and to which I went as a boy. The fact that I attended the school during my adolescence is significant. It puts me in a unique position -- that of being the only apparent person who can design them a building and, at the same time, really understand the needs which lie behind that building. It also means that I am biased and see the school through a very strong personal interpretation. I think, however, that this latter fact is true of all the people involved with the school and that it does not change the validity of either my interpretation or of this thesis.

THE BASIS OF THE PROBLEM

The Putney school is a boarding school in Vermont on a very beautiful windswept hilltop. It is a college preparatory school and it is coeducational. In the past it has gone under the name of "progressive". I feel that this word casts rather an unfriendly spell and wish to avoid it. When the school was first founded, it was the first one of its kind and a rather new idea in education. Geneologically, its nearest ancestor is the Shady Hill school in Cambridge, Massachusetts. The present headmistress of the Putney School taught there before she founded Putney. Since the founding
in the middle thirties, the idea has spread and Putney now has become the leader of a whole group of schools.

Putney had its beginning in the buildings of a farm with a handful of students and a vast amount of pioneering spirit. All the people involved lived together, learned together, and worked together. They strived to build a community in which college preparation was only a part of their effort. They operated the farm, built new buildings, took camping trips, skied, played music, sang, danced, and studied -- to mention only some of the various activities.

The beginning was naturally tentative and a bit experimental. But the school thrived and succeeded and is now a going concern in which this tentative quality has gone. Instead, it has been replaced by a body of tradition perpetuating many of the earlier forms and pioneering activities. There has been evolution and a changing and trimming of the pattern of the daily life both to improve it and to meet changing external conditions.

The life at the school contains a very important contrast which I think is important to mention here. There are large scale activities involving everybody and which are semitraditional. Opposed to these are the single individual activities of the students. There is something about the balance between these activities which gives Putney life a certain "scale" and
which has a very pleasing proportion. I cannot put my finger on it any more than this, but I feel it contributes very much to the "well being" which the community possesses.

Putney life is very full and busy for its students. Each day is a many-layered sandwich of activities in which the student does a little bit to each one of the layers. The next day he does a little more, and so on. Each activity is returned to, each day, by the student, and pursued a little farther toward completion. This analogy is a slight oversimplification because the daily schedule does change in detail during the week, but the way the day is broken up into little units of time is standard. This pattern provides great variety as well as continuity, and permits a very beneficial sort of cross-correlation between activities and between disciplines. This pattern is true in most every school, but at Putney it is much more predominant and, I think, effective.

The daily life of a typical student might go something like this:

7:00 a.m. Rising bell rings
7:30 a.m. Breakfast (served by fellow students)
8:00 a.m. Back at dorm - sweeps room, makes bed, and tidies up in general
8:30 a.m. First class begins
9:50 - 10:00 a.m. Change and then second class.
(80 minute classes)
11:20 - 11:45 a.m. Meeting of whole school in assembly hall. (Announcements, daily business, etc.)

11:45 - 1:00 p.m. Third class

1:00 p.m. Dashes over to dining room and waits on lunch table (this particular student's household job)

2:00 p.m. Fourth class

3:20 p.m. Runs home and changes clothes for work job, or skiing, depending on season (work job for our purposes)

3:30 - 5:00 p.m. Works on woods crew (his particular work job) cutting firewood with his axe.

5:00 - 6:30 p.m. Bangs around in his dorm and gets dressed for dinner (shirt, tie, and jacket, etc.)

6:30 - 7:00 p.m. Dinner (served by fellow students who have already eaten at 6:00 p.m.)

7:30 - 9:30 p.m. Goes to evening activity which may be anything from orchestra to blacksmithing. The idea being that it is a cultural activity with artistic and creative possibilities. There is a large variety of these and the student is free to choose his activities at the beginning of each term.
9:30 - 10:00 p.m. Returns to dorm and gets ready for bed.

10:00 p.m. In bed, lights out and a student putter-to-bedder checks everyone in.

The whole preceding schedule is punctuated by a bell which consists of the tire off of a locomotive driving wheel hung on a tree and struck by a sledge hammer. It is located pretty much at the center of the school and very definitely regulates its life.

Left out of this daily schedule are some of the important community activities which I mentioned earlier. These all take the form of some sort of large participation by the whole school. For instance, there is the Friday night singing in which the music director puts everyone to work on a Bach choral which they will perform at some time like Thanksgiving. Then there are the square dances in which everybody whoops it up. There are the ski trips in which the whole school goes to Stowe, and there are times such as Thanksgiving at which there is a great feast and all parents are invited, and afterwards there is a play given, followed by a square dance. An attempt is made to space these large scale activities fairly rhythmically through the year.

The student at Putney also has his solitudes and they come in various ways in various places. He is sometimes alone in

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his room. He can be alone on his skis while coming home from the particular slope that was used that day. On weekends, the students can make up pack lunches and go on long hikes in the woods or along the dirt roads which abound. There is great solitude in the Vermont countryside for oneself and for ones special friends. The student can also be very alone in the study hall, or library, or with his cello in his practice room.

One of the most important facts in the life of each student is the out-of-doors. The school consists of many smallish buildings spaced around on the hilltop and every change in activity usually requires a change in buildings. Very soon the student becomes impervious to water. Almost all of the work jobs are outdoors, all the sports are, and all of the locomotion is. Putney to the student is a sequence of views, vistas, spaces, buildings, sounds, physical impressions of cold and wind and exertion, all strung out along his daily route in between various mental activities. This daily experience of everybody is very dynamic and very varied.

Just as the educational experience of the student can be thought of as a sequence of experiences spaced in time in a certain order so also is this other type of experience a linear sequence carrying a corresponding order. I do not have a ready name for this sort of total experience. It is the type of experience which architecture provides but it is much more inclusive than the usual meaning of architectural experience.
If I were given the freedom to define architectural experience, then I would define it as this sort of total experience. This is my own personal view of architecture but it should not be made into common currency even for the purposes of this problem.

To me this total experience is the vital contribution which Putney has to offer. I believe it is inadequate to try to chop it into smaller ideas and to say this one is good and does so and so ... etc. The place, or the school, however one wishes to call it, is a very intricately woven fabric all held together by the linear path of the student from the beginning of the day to its end.

It becomes very important to me to know how the factors of a student's life are distributed along this circuit. The time sequence has been carefully worked out already by the school but the space sequences seem to be an unconscious byproduct of the other, or determined accidentally by the way the school has grown. Up to the present, the school has grown in a haphazard and scrambled seeming manner much of which was forced upon it by the original buildings. In its early stages the school was much like an overcrowded house with practically all activities occurring under one roof. As more buildings rose, activities became more and more separated each to its own building until now the school is in a semi-mixed stage. Still, however, the school has to tolerate music practice rooms scattered all over the place in any
nook which is available, student dorms also spread all over the place, some in old farmhouses which are far removed from the top of the hill, classrooms in the administrative building, roads running smack through the center of things, farm-lnad mixed in and so forth. It looks unorganized. It is, if one believes Putney should be highly rational and highly ordered.

But due to this scrambled quality, the space sequence of each student's life has been a thing full of richness and variety and of various beneficial forms of intrusion. All day long he wanders back and forth over the hilltop, crisscrossing the same places but always at a different time of day and quite often from a different direction and with a different purpose. As he does this, the paths and activities of other students intersect his. At first in the morning when he goes to the barn to do his chore before breakfast, he has solitude, -- there is only the sunrise and the mist in the valley and himself. At breakfast he is plunged into a tangled crowd all furiously feeding. On the way to his dorm he passes by a hidden nook from which emerges the strains of a flute. Someone is practicing his Handel. Before he reaches his dorm a truckload of grain will go by and the farmer who is driving it (and perhaps is his friend) will wave at him. These are intrusions. The view of Mount Monadnock, and the wind which is on the other side of the corner of a building are also intrusions. What I have described here is only a fragment of the total.
With this large variety of little impressions and experiences, the student performs cross correlations and links up similarities, and so forth, as is the habit of the mind. Each time a thing like this happens, new meaning is given to the individual incidents or perhaps to some large activity. It is this process which is vital to the job which Putney does. A very common experience in the school is that the freshman does not like his afternoon work job whereas the senior loves it. To the freshman it is purposefully constructed manual dog-work, expressly for his betterment and displeasure. To the senior, it is a chance to get outdoors, something he has come to love very much, and to do his bit toward making the place run. This is a thing which has meaning and makes sense, because the school relies heavily on his labour and responsibility. Very often a student will take an entire weekend and work. This is not altruism, he loves to do it. What is it then that urges this transformation? At best perhaps I can only mention things which contribute to it. First, the student has grown up, has developed a sense of responsibility which is an outgrowth of a feeling of belonging to the place. Secondly, this feeling owes, in the end, its existence to the fact that the student loves the place itself in some way or other. It is an emotional transformation. How and for what reason does he love the place? If one asks the students themselves, they will tell you it is beautiful. If one pursues them further, they will go to little things, the details. It is the mist in the valley, or the fall colors, or the horses, the open feeling, and so on, but they are not very articulate about it.
I can try to amplify this from my own personal experience. It is my belief that the student comes to love his total experience bit by bit through its little individual fragments, and that it is this large cluster of happy and beautiful fragments that he lumps together in his mind and calls Putney.

There now emerges in my picture of Putney, two factors which are vital determinants of the school as it is today. They are 1) the pattern in time of the activities in which the students participate, and 2) the pattern in space of these activities and the other experiences of the student. At present, the temporal pattern is the one of which they are conscious at the school. It is subject to the forces of tradition. Many of the items which make it up are new Putney-type traditions. A good example of this is the Harvest Festival which is one of the large all-school activities. Essentially, it is an adaptation of the old and well-known county fair. The space pattern is a less evident factor in the school. It has largely been haphazard and probably is not yet well recognized.

In physical aspect, it is best to think of the school as a "place". The unit which first comes to mind is the entire hilltop. The hilltop is a ridge which runs north and south rising slightly to the south. It slopes off steeply to the east where there is a view of the Connecticut River valley and New Hampshire, and Mount Monadnock. To the northwest
there is a very complex valley which ultimately gives rise to a higher ridge of hills. It is from here that the wind comes. To the southwest it is fairly flat, running off into woods and then to a higher ridge. In all directions away from the hill there are gorgeous views. These views cannot all be seen from the same place but each has its best vantage point. There is a capping of woods on the highest point of the hill and slightly south of the buildings. All around both of these is the farmland on the hillside and at its edge either adjoining farmland or woods. The buildings occur in two groups, the school buildings and the farm buildings. The farm buildings are to the southwest of the main group. The main group are sort of a "collection" most of which were adapted from the old farm buildings. The Old Boys Dorm is a made-over carriage shed for example. The barn used to be located in this group, but it burned down and was rebuilt in its present location -- much larger. This moving out of the farm activity has had the effect of removing the farm as a strong influence on the school life. In some circles this is felt to be a regrettable price to pay for a more efficient farm.

The main group of buildings are all painted white and are quite similar in character, but not in size and shape. They all have an appearance of "growth" about them, with pieces added on and bulges protruding and new wings attached and so forth. They are located in sort of a rough ring, oblong in
shape which straddles the ridge. The interior of this ring is a very interesting open space crisscrossed by roads and paths and spotted with trees, both in clumps and singly. The siting of the buildings which roughly mark out this space is irregular and quite unplanned seeming. The total effect of this arrangement is one of informality which is tempered by the traditional New England "white". Located downhill to the east is an attendant group of service buildings which are much smaller and are scattered into a smaller area. There is no restful pattern in their arrangement as with the larger buildings. But they are located downhill below the view and there has been no place from which to view their disorder until recently a new classroom building was built which directly overlooked them. It has been interesting to note that coincident with the building of the new classroom building there has sprung up the feeling in the school that they are being crowded out by lots of "little" buildings.

The quality of this central space is very important to the school. It in no way obscures or excludes the beautiful views beyond. Instead it provides them with a very pleasant frame of reference. It is sufficiently enclosed so that it is recognizable and has its own intimate interior views to offset the grand ones outside of it. It is the geographical center of the school and right in its middle is the tree with the bell on it. This bell is one of the school's more important physical traditions. It is not an activity which is a
tradition but it is a "thing" which is a tradition. I believe that the open space itself is also a tradition, in the physical sense I just mentioned. It is the scene of a large part of the locomotion and of many of the festivals. It very definitely comprises the physical core of the school if such a thing exists. It gives the feeling that it "is" the school. The people at the school are aware of this and new buildings are not allowed to intrude either into it or upon it although its perimeter is far from completed by buildings. It is this awareness on their part that allows me to call it a tradition.

The school possesses only one such nucleus and the adjoining spaces, where there are any, are either bulges connected to it or to the great outdoors beyond. There are some very nice transitions of this nature. However, all the activities and buildings of the school do not occur at this nucleus. The most notable example of these are the outlying dormitories. It is a circumstance, which as almost become traditional, that the school has never had enough living space for both the students and the faculty in the buildings on the hill. Because of this, it has had to resort to outlying buildings usually connected with nearby old farms which are not productive any more.

The result of this is that the school structure has been concentric about its center with "out" buildings and "in" buildings. All the "out" buildings with the exception of the farm
have been faculty houses and student dorms. The "in" build-
ings have contained dorms as well as all the other activities. This situation has provided the greatest possible variety of living space. It has also provided the greatest variety of location and siting with the consequent effect on the experience of the individual residents. At Putney students change dorms and roommates each year, so this situation has allowed each student to live in a unique place each year. Along with each unique place goes its attendant unique views and spacial experiences which make up a student's total experience. It has thus been possible for Putney always to be new and different each year for a given student. The place has been able to grow along with its student. Obviously, there are other parts of the school which remain physically the same such as the situation on the hill. But the place where the student lives has in the past been able to satisfy this one important criterion -- that of being a unique place, a particular home, which is not like any of the others. This completes the picture of informality and of community.

Along with this physical variety is a consequent social variety. Group sizes have been very different and the relation of the residing faculty to the group has run the gamut from intimate to formal.

There is a quality of austerity in the natural setting of the school which I want to emphasize. It is important that I do
it because there is so much description of the warm and human qualities of the place. These warm qualities are often contrasted, especially in winter, to a very harsh and hostile nature. This section of Vermont is rugged and bony and very unsheltered. The vegetation does not grow to lush proportions but remains smaller and more limber. Its resilience seems to be necessary to its survival.

The most unsympathetic force in nature is the wind. There are times when it really batters the school. The snow which is often picked up by it becomes forced through inconceivable places and is deposited on the inside of the buildings. Huge drifts are built right across paths. Often in the winter the school consists of a network of tunnels dug through these drifts. In this season the world is made up of two colors, white and blue, and the rampant being which is the wind. There is a crystalline quality to this which reaches deep into every human being there, and washes very clean.

There are other times in which the mood is all brown and drab. The earth is all brown and the trees are all brown and the drizzle is all brown. It is immensely discouraging. Against this backdrop the buildings stand out in the traditional and austere New England "white".

There are other times, however, such as May when life and growth literally bust out all over, like a spring coiled
up in a winter long box. The effect of this on the people at the school is equally profound.

Also there is the sky. There seems to be more of it than there is ground. It is always changing its mood and its behaviour toward the school. There is so much of it and it is so powerful in what it expresses and does that the human individual is very meager by comparison.

At first it might appear that this very dominant quality of the surrounding nature were hostile. A first impulse would be to protect people from it. This, of course, is impossible unless one encloses the entire school in a frosted plastic bubble. It is important, however, that some contrasting qualities always be present either in buildings or in some other aspect of nature itself. I think that this has always been true of the buildings and their arrangement. I have tried to show this in my description of them, how they have warmth and informality and a human quality, because it is important that they are this way in this larger natural framework.

I believe, however, that this dominant nature is something to which people should be exposed rather than protected. There must be relief to be sure, but the existence of both at the same time and the contrast which they present is important. This has been an important ingredient in the school in the
past. It has been an important contributor to the strength of the experiences which make up each student's total experience.

The buildings themselves are not all warm and informal and "human". Their character contains these elements but at the same time, it reflects the austerity of the natural surrounding. In the siting of the buildings and the quality of the "focal" open space the austerity of the larger surrounding is not reflected. But each building has a very "Vermont" and "New England" feeling by itself. These buildings are often framed by the larger views rather than the more intimate open space and it is appropriate that they are sympathetic with them.

To me it is the mixture and the contrast of these two basically opposite characteristics which contribute to Putney's strength.

I mentioned earlier that the school had suffered from a haphazard growth and that it seemed to be in a condition which required further straightening out before it would become orderly. This brings me to the subject of the generalized needs of the school. There are two immediate ones which are evident. One is the need for some sort of master planning and overall coordination which understands what makes the school tick and could chart the manner in which it should
develop. The other is the need for more buildings. The latter is the more urgent. First on the list are dormitories. It is felt that these would relieve the load on the hill and that the other activities could then move into the vacated buildings. They would only need to be remodeled again. This process would be a sort of "moving out" of the living quarters to an outlying area. Also, however, is intended a "moving in" from the outlying districts. The vacated "out" buildings could then be used for the faculty with families. The new dormitories would wind up just a little bit away from the center in a position which would be neither "out" nor "in".

What I have just explained is what the school thinks about its building problem and why they put the dormitories first. I got this view from talking with them, and I also agree with it. In regard to the first need, the school does not seem to have an opinion, or to have thought about it much. They are very busy and are only able to consider the next step. This is the same process, of course, which got them to where they are now and it has been successful.

They all agree, however, that some sort of overall coordination is soon going to be necessary. They realize that the school has passed from its pioneer stage with its attendant roughness to a stage in which it is the example of its kind. It must be further worked out and perfected in all its details if possible. This includes better living space for many of
its activities which are now housed in quite battered build-
ings. They are partially aware of the importance of the phy-
sical form of the school as an instrument for attaining its
objectives. They are aware that new buildings have the power
to disrupt this already existing and successful form, and that
master planning considerations are immediately evoked by the
need for even a single new dormitory. In order to properly
place the new building with respect to the rest of the school,
the basic outlines of the school's future development must be
understood. The two problems are very intimately connected.

This need to understand what makes the school tick and to
plot its future course of development requires a very keen
perception of the way the school works and of its objectives.
There are probably many views on this and definitely certain
disagreements. The total Putney is a very delicate instrument,
probably not completely understood by any one person. At any
rate, I do hope there will be some contribution lurking in the
way in which I see the school.

I wish to beg the problem of describing the objectives of the
school and would prefer to scout around them, in general in-
dicating their nature and quality. To do more than this is
outside the scope of this work and of the author's ability.

What the school tries to do I think is to build as complete
a person as possible out of the raw material which comes to
it in the ninth grade. In doing this it has in mind an ideal of a complete and well-developed personality which is different from and more developed than the common idea of the well rounded personality. It represents, to me, a step forward in the evolution of this idea. I believe the instrument which builds this character in individuals is the community life which they have designed. I believe also that all those aspects of the life they lead, which were not designed, are part of this total instrument. These aspects have naturally come along as byproducts of the conscious design and of the original situation. This leads directly to the physical quality of the school which I believe plays a very important part in this personality building. Perhaps this is a thing which is well recognized at the school, but it is my impression that it is not.

I have mentioned before the scrambled character of the school's growth and how it implies incompleteness and a job still to be done. This scrambledness is something which they are trying to rid themselves of at the school. It is felt that it should be replaced by some sort of rational order. They have begun to allot areas to activities. The farm now has its own region. The dormitories it is felt would be best if located all together and slightly away from the center of the school. All the classrooms are gravitating toward their own area, the administration is becoming centralized at last, and so on. Music has been left out and it is still all over the place.
The art studio, however, has always been located way off in its own place since very early in the school's history. Music has been a very important ingredient in the school life and art has not.

I now come to a most vital and important point. It is this: this scrambled quality has been the prime contributor to the richness of each student's total experience. If all the students started using the same path to go to all of their classes, for example, Putney would have lost something priceless. The fact that on a spring day music seems to exude from everywhere is a vital educational factor. Let us take the music situation as an example. If all the music activities someday were located in one place, practice rooms and all, the following would happen. All the practice rooms in order to operate in close proximity to each other would have to be acoustically treated so that there would be no cross disturbance. Once this was accomplished, nobody save the practicers would hear music being practiced, even on a lovely spring Sunday. I believe the effect of this would be that music would then cease to be an important ingredient in Putney life. This is exactly what happened to the farm as an ingredient in everyone's life. Nature and the weather probably cannot be so isolated. The art studio on the other hand has struggled under this type of handicap since the beginning.
It is vitally important where and how often various factors and influences are located on each student's daily circuit. Anything which is located in a dead end space off of his circuit does not exert any influence. A case in point are the common rooms. Nobody uses them and they are wasted. The places which are active, socially and physically, are all the crossings of paths and important hallways, etc. This is an empirical observation on my part, and I think the reason for it is the tremendous energy of the life which permits little time for people to accumulate in little collecting places away from the main stream, and if a person leaves the main stream, he does it because he wants solitude instead of company.

There is another effect caused by the "scrambledness". It is a general quality, a sort of feeling, which it imparts to the place. This feeling is partially described by the word "informal". The feeling is intimate, human in scale, and comes partially from the character of the buildings and partially from the way they are sited and partially from the lack of any "militant" or categorical order in which they are arranged. The result is a certain feeling of "scale" which enables the student to feel that the place is a home. There is also a pliability to the place and to most of the buildings which convey the idea that they are capable of being used in many ways and this enables a person to feel that the place is friendly and assists him in the uses he would like to put it to. This whole atmosphere connotes the possibility
of uses not yet thought of. I consider this a fertile framework for any creative activity.

This effect of which I have just spoken is difficult to pinpoint, or to hold up and look at. Nevertheless, I think it is very real and that it also is very vital to Putney. What would happen if the place should acquire a character such that it didn't feel like a home to the student? In such a situation it would probably appear very much an institution to this particular person. Immediately the whole relationship between the student and the school will be changed. Perhaps it is best to return to the work job example in order to see how this change might alter the accomplishments of the school. In this earlier example, I state I felt that the school really did its job only when it succeeded in reaching the individual student in some emotional way such that he felt a sense of identification or belonging to the school. Only then could he really participate in the community and thereby grow. I feel here that if the student cannot make an emotional home out of the school, then he cannot achieve this sense of belonging. Instead he will treat it as institutions have been traditionally treated, with no respect and with rejection. Perhaps lip service will be rendered, but basically the student will remain alien.

To sum this up I feel it is vitally important for the school to feel like a home and not like an institution if it is to reach its students.
To me then, it is important that certain of the physical patterns which Putney possesses at the present, and has possessed in the past, be retained. These patterns appear on the surface to be harmful but with closer examination they turn out to be some of the reasons why the school has succeeded so admirably. They concern this thesis because they indicate how the new buildings should be located and what their general nature should be, if they are to fit in and assist the school in its work.
The immediate problem of the school and the subject of this thesis is the provision of more living space for both students and faculty. The buildings they feel they need most are new dormitories for the students so that some of the older buildings on the hill may be vacated. It is not intended to vacate all of the dorms on the hill. Some of them seem to be satisfactory and will be retained, perhaps indefinitely. One reason is that they will not easily remodel and another is that their location and construction are very good for their purpose. However, the combined requirements for new living space resulting from the discontinuing of the "out" dorms and the vacating of certain of the "in" dorms will be considerable, amounting to about two-thirds of the school's total capacity. The school expects to build four or five new buildings, maybe as many as six, to meet this need. They have chosen a new site in an old and rocky horse pasture slightly downhill and to the east of the main buildings where they intend to put all of these buildings together in sort of a secondary campus. These buildings would be below the line of sight of the view and partially hidden in some trees. They would very definitely be "away" but not very far away.

The type of building they would like is very interesting and to my knowledge has no prototype. I don't know how long the idea for it has been developing up there with them but I do
know that they were never able to get their idea fully into practice. They were always frustrated by the form of the existing buildings and by the makeshift solutions which were forced upon them.

What they would like to have is a home for a moderate sized group of students and a faculty family. The number of students, they decided, should be about sixteen. This represents a compromise between economy and what they feel to be a better group size, which is around twelve I believe. The faculty family should have no young children of their own, so that their energies may be given to the students and so that they may more readily get to know the students personally. It would be quite all right, however, if the faculty children were of Putney school age. It is wished that the students and their semi-parents will live in as much of a family manner as possible in this home.

There are, of course, certain inherent limitations to this idea which crop up when it is applied to the Putney school. It is not possible now in the school to perform all of the important family functions in each living unit. Eating, for instance, is already centralized in a large dining hall, and quite properly I think. There is a deviation from this in the form of the Sunday "dorm breakfast". Breakfast is sometimes cooked in the dorms; there is a leisurely atmosphere and it is a fine time to have girl or boy friends come and
for all to have a good time with the faculty couple. Perhaps this institution can be expanded into an important function of the semi-home. Sometimes, some dorm groups will have an open house which works somewhat in the same way. Aside from this exception of eating, all other important and basic home functions can, I think, be provided. The students can certainly be provided with solitude, study space, sleeping and dressing space, a living area of their own, and all the necessary mechanical equipment. Perhaps certain psychological functions cannot be provided because the faculty are not the real parents. It is equally possible for the same reason that certain others could become possible. The idea is not to recreate the earlier type of home but to build a sort of transitional home which lies between the childhood home and the larger society.

Since I went to the school and have views about it, I must now add, at this point, my views concerning what they wish and what they need. I have already pointed out certain of the qualities of the school as being vital to its functioning and tried to show why. Now I wish to develop this and show how the furthering of these vital qualities affects the thinking of the new living units. It is my feeling that if the design and location of these units were poorly handled, substantial damage might result to the school.
I am very enthusiastic about their idea of the student-faculty house. I think it is exactly what the school needs and the more of a home it can be the better. During the discussions with them, in which I was still learning what it was they wanted exactly, a point of interest and of importance arose. It is this: there is a conflict between the private life of the faculty couple and the semi-private life they are to lead with the students. If the house is to work at all, the faculty couple must be located so that an intimate connection with the students is possible. This kind of location abridges their personal privacy. If their privacy is sufficiently abridged, they become forced to protect it with a psychological barrier which then spoils the "entime" they are supposed to be building up with the students. This conflict then has to be solved before the house can really work. It cannot be solved by removal of either party so it has to be solved by some special spacial relationship within the house. This, then, is one of the jobs which the house as an instrument, must perform.

Another job the house must do and one which previous dorms have not done, is to provide a homelike living area which is centrally located and which provides a focal point for student social life. This, of course, was the purpose of the common rooms but they seem to have failed because they were not centrally located. I also feel it is desirable to emphasize the "living room" character of this space as much
as possible. If a space like this could be made so that it really worked, the job of the faculty would be greatly implemented, because there would be this convenient space in which to find all the students who did not wish to be by themselves. An intimate connection of the faculty apartment to such a space would then be almost ideal, provided it could also be isolated.

A third thing the house must do is possess a very intimate "scale". A quality such as this will contribute to its home-like character. It will also, I think, clarify its relationship to the rest of the school. It is a building for more relaxed activities and for smaller groups than are most of the buildings on the hill. If this is so, then the house should say so when one looks at it and feel this way when one is in it. I also think its friendliness will be increased if it feels the right size to those who use it.

The relationship of these houses to the main building group on the hilltop is a matter which strongly affects the quality and the character of the whole school. There are physical traditions affecting this relationship which I think should be respected. These traditions have grown with the school and embody conditions which are necessary to its function. These traditions are basically two. One is the "scrambledness" of the school, and the other is the "focal" quality of the central open space on the hill. I feel that
it is very important in locating the new houses not to disturb these two existing conditions.

Each house must have as much variety of site as possible. Every effort must be made (within reason) to make living there a unique experience, and moving to and from them a unique experience. This means that the houses must not be put together in any one place but must be scattered around in a variety of places. In this scattering process, care must be taken to keep the central open space as the focus and also to keep it free from intrusion. When siting each house I believe it ought to be tucked away as much as possible into some little cranny which is seldom frequented but which has some new and intimate viewpoint on the world. If this is carefully done, there will be no feeling of being "crowded out by little buildings" because they will be well scattered and hidden and the serenity of the central "focal" space will be preserved. Also its "central" quality will be preserved. The house itself, if tucked into a little cranny of sufficient intimacy, will feel as though it belonged there which would be very nice. Also on harsh windy winter days, this sympathetic character will be extra nice -- if not fundamental to Putney.

Now I come to requirements of the houses which are in conflict with these sentiments. There is conflict between the need for uniqueness and the need for generality. The very
act of breaking up a student body into groups of sixteen with faculty attached is a standardizing process. All the units which house these groups will have this important characteristic in common -- size. If this must be done for reasons of economy, then it must be accepted and it means that all the units can be satisfied with one solution, a standard solution. There is an attendant economy in that they will thereby be easier to build. This at first seems unfortunate. It appears that a standard building could not possibly satisfy the need for being unique. It now becomes necessary to see exactly what it is that needs to be unique.

As I see it, it is the experience of living there which must be unique. In any form of living, there are many things which are standard and constant throughout a group, although each individual in the group may feel that his experiences have been unique. I am sure all the beds in Putney are very much alike and that no one feels standardized by this fact. The same is true of ski racks and skis. Skis are fundamentally exactly the same and yet can be very different from pair to pair. I think the same can be true of variations of a standard building. There are many things about the job these houses have to do which will be the same for all the houses. There is, so to speak, a standard social problem to be solved. Certain forms will solve these standard problems and must occur in all the buildings.
The experiences associated with a building come from many things. They come from the trees and land around the building, from how it is placed with these things, from what is viewed when standing in its front door on the way out, from the things seen and passed and heard while on the way to it, from its color and materials and shape, from what happens inside of it and so on. Most of these impressions do not come from the property of the building which solves its social problem -- namely its form. There are many characteristics about the building which are left free to be varied and made individual -- even with a standard building.

So because of these considerations, I think a standard solution which is capable of variants in relation to the ground and in materials and colors is the one which should be sought. If the unit can be made sufficiently flexible it will serve its purpose best. It must be remembered that one of the most important ways of making this house unique is to locate it by itself in a unique natural setting.

This type of solution is a compromise between the two needs, the need for uniqueness and the need for generality. Other ways of trying to meet both requirements are probably possible but I feel this form can be made to do the most with the least, which is important.
There is another conflict which pertains to these houses. I have mentioned that they should be "intimate" and "sympathetic" in order to best serve their emotional purposes. I have also mentioned that the school has a strong "austere" nature which is an inherent part of its emotional pattern, and that most of the buildings reflect this basic "New Englandness". This mood is very strong and pervasive. I feel it would be wrong to build a building which did not reflect its physical surroundings in this way. I think a building which did this would be insincere, especially at Putney which is so direct and honest, and where every aspect of the life is so strongly influenced by this predominant force of nature. Perhaps it can be said that this is another of Putney's physical traditions which must be continued if the present character of the school is to be maintained, and even, furthered.

Each house then must both reflect this "austere" quality and be "intimate" and sympathetic". At first, this also sounds like a contradiction. One nature connotes formality and the other, informality. One connotes hostility and the other, sympathy. Maybe, on the other hand, we have only a problem in words. If a building were clean and simple and strong, it would be "austere" but would not be hostile or necessarily formal. The coziness and informality might come from its size and "scale" and arrangement of interior space so that it cooperated with its inhabitants. The cleanliness
and simplicity and strength might come from its form and proportion and color. It is true that the resulting house can be neither wholly informal and organic or totally "austere" and formal. It somehow must do its best to satisfy both requirements.

I think now I have progressed as far as is practically possible in thought which is not expressed with pictures. I propose to let the final design clarify this problem by itself. It is sufficient to explain that this conflict is one of the ingredients which should go into it.
THE PROGRAM

It is probably a good idea to boil all of the preceding down in one place into a sort of "official" list of requirements or "program". Perhaps also I ought to mention that the manner in which the solution was arrived at was not as logical or methodical as this report would imply. A lot of the features were arrived at in a sort of intuitive manner and only fully understood afterwards. I don't believe this challenges the validity of the solution if it can be shown afterwards that the features are correct. In many ways the preceding discussion is an explanation of why I have worked out the particular solution that I have rather than a record of its process.

The client needs a prototype house which will be the "home" for sixteen students and a faculty family. The client hopes to build a number of these houses and it is necessary that they be capable of a variety of relationships with the ground and of a variety of external appearance. It is also necessary that they be a standard solution in which the interior form of all the houses is the same.

This home must perform the delicate social task of enabling a married faculty couple to live closely and intimately with their group of students and yet feel that they have the proper amount of privacy necessary for their own personal lives.
This home must also provide the students with a nucleus for their own social life which will not intrude upon either the privacy of the faculty or the privacy of the individual student who seeks solitude in his own room.

This nucleus must be so located and of such a character that the students will both use it and come to think of it as their home. It must also permit a large variety of activities so that it will not in any way restrict the student's ability to use it.

The house must provide each student with a bedroom, bed, closet space, and storage space as well as the necessary plumbing facilities. Students at the school have traditionally had one or more roommates and it has not been necessary for a room to contain more than one study desk for every two persons. This is a byproduct of the unique study program they have. The house should try to provide as much variety in the rooms as will be consistent with the rest of the solution. This means different shapes and different numbers of inhabitants.

The principal of pliability and usefulness must be applied to these private rooms as much as possible. They must be capable of rearrangement and the surface materials must be chosen so that the students may hang pictures and put up shelves, etc.
The house should provide a suite for the faculty containing a bathroom, bedroom, and living room of some sort. It must also provide a kitchenette which is accessible to both the student living room and the faculty living room. This kitchenette will enable the faculty to have meals in their house which is fairly often the practice at the school when it is possible. It will also be a place for students to keep the extra food they always seem to be indulging in, and it will be used for the Sunday house breakfasts.

The house must provide adequate storage space for trunks, skis, and storm windows and screens. This should be a large and fairly central room rather than space distributed in each bedroom.

The house must have a furnace and a hot water heating system.

It should be attempted to provide the house with some form of outdoor terrace adjacent to each living area which will create a pleasant transition when entering the house and which would more visibly link the house to its site. Such a terrace would be very useful, for instance, for a Sunday house breakfast in the spring when the weather is lovely. The students love to be outdoors in any sort of nice weather and it is hoped that the terrace will provide a place to come and go and to just sit around in.
The house must possess an intimate "scale" in order to give it meaning in contrast to the rest of the school, and it must also reflect the strong "austere" quality which pervades the countryside and other buildings.

Each house must be sited by itself in a unique location and in such a way that it is mostly hidden from the main buildings. It must also be placed so that the central nature of the main buildings is not disturbed. It must do this in order to carry on an already existing tradition concerning the school's living units.
THE SOLUTION

In this solution I have felt that simplicity and clarity would be important. Perhaps this can be paraphrased by the work "directness". I have tried to solve the problem so that it would be like a fraction which could not be reduced. In this approach I felt lay the greatest chance of achieving the difficult combinations of "scale" and "austerity" and of "generality" and "uniqueness".

The most important problem to be solved and the one which had to be solved first was the problem of the social conflict of the privacies. To do this the house had to really be two separate houses, each with private rooms connected to a central living area, which were connected together in such a way as to permit both an intimate connection or isolation. The important feature is that the provision of either the isolation or connection is left up to the choice of the people in the house. The house itself permits the possibility of both. The device used to achieve this flexibility is a buffer space introduced between the living areas of the two units. This buffer space is the kitchenette which can serve either space or both spaces and which can either be a passage between them or a buffer zone between them. There is purposefully no other connection between the two units. The two separate houses are both under one roof because the solution works out that way and because it is important to indicate
that they belong together in one house. Any more separation than is absolutely necessary, either real or suggested, would reduce the "family" nature of the relation between the faculty and their students. This would be distinctly undesirable.

In pursuit of "directness" all the student bedrooms are put in one place and treated the same way. After all, they are very much the same in purpose. Why not say so? Therefore, all the bedrooms and the bathroom are upstairs and are reached centrally by one set of stairs. This way they will be private and quiet. The bathroom is there so that the dressing and associated activities cannot be disturbed by intrusion from outside or by the faculty.

The rooms are all a little bit different but very similar in character. Since they are all on the second story, they all have a sloped ceiling which is really just the underside of the roof. Their sizes vary so that there will be many combinations of rooming possibilities. Along with this is a consequent variety in shape. The variety is small, however, and all the rooms except the end two fit into the same unit width which is a multiple of the module of the building. This module I will describe later.

Because of the modular nature of the second story, the fenestration is able also to be modular and to fit directly in, forming a regular and clean-cut pattern. This is more
"directness" and "simplicity". A standard window is then used throughout the entire upstairs. Standard glass is also used throughout.

The first story of the house is divided up into two basic parts which are separated by a zone containing the mechanical facilities. The faculty apartment is at one end and the student living room is at the other. Exactly in the center is the furnace room and between the two living rooms is the kitchenette. The living rooms are both on the same side.

This first floor is where the house is entered and where all of the non-private social activities are held. It is also the part of the house which comes into contact with the ground. The first floor is planned so that two sides of it need no doors or windows. These are all placed on the other two sides. The blank sides may then be both turned toward the wind and dug into the ground. When the house is placed on a hill and its back side is dug into the ground, the front side will open out at ground level onto the terrace. The faculty living room will open out at the open end onto its own terrace. In some circumstances, this terrace will have to be cut out of the hill and in others it will have to be built up. The two blank sides of the house enable it to be dug into the ground in many ways or not even dug in at all. The front side will always open out to the downhill side and to the view. In order to enter the house a person must walk around it to the open side and then enter with his back to the view.
The student living room is entered directly from the outside. It is to a certain extent a very enlarged entry. It has in it the ski racks and the coat closet that an entry would have. It also has a table in it on which to dump books and leave things. This is all done on purpose to avoid the fate of Putney's other common rooms. The stairs to the second floor leave the living room at the place where the coat closet and the janitor closet are. The janitor closet contains the trash barrel and all of the cleaning materials, including a sink, which will be necessary. The rest of the living room is a dead end space in which will be the usual furniture. It is intended that when a student enters the house he will take off his outside clothes and leave them downstairs and then relax in the living room without bothering to go upstairs unless he has a special purpose there. Certainly, if there are already other students in the living room, it will be harder for him to leave. He will never be able to ignore the place because he has to pass through it every time he enters the house.

The faculty apartment is separated from the student living room by the kitchenette and the furnace room and the faculty bathroom. These three rooms form the isolation zone across the house from outside wall to outside wall. The operation of the apartment is standard, the only unusual thing about it being the way the kitchenette links it to the student living room.
The downstairs has a smaller area than the upstairs which projects forming a two foot overhang all around the house. It is also constructed of a different material. Since its walls are dug into the ground, they are made of masonry block. The treatment of the downstairs will be the same for all of the houses although the way they will be dug into the ground will be intentionally different, as will be the different arrangements of the terraces.

It is intended to achieve the variation which is hoped for by varying the color and material of the upstairs part of the house as well as by changing the relation with the ground. Primarily, the difference between the individual sites must be relied upon. The change in the house, however, can attempt to reflect the predominant characteristics of the site. A house set in the middle of a thick woods could be finished in boards and battens which are stained red. Then, in autumn the house will be red in a woods of yellow trees and brown trunks. If the house were place at the edge of, or in an open windy field, it could be dug deeply into the ground and its upper floor finished with modular plywood panels which are painted blue. The little trim strips which cover the joints could be white. In winter, this house seen against the blue sky and on a white field could present a striking image. There are other possibilities; brown stained houses among pine trees, white houses among other buildings,
and many others. With different terraces and relations to the ground, and each located in a unique site, these houses could all be as unique as any one would wish. Certainly, there is no danger of a "similarity" of experience between any two of them.

The module of this house is a unit dimension which is 37-3/4". A module is basically a device for the coordination of dimensions. The module of this house applies only to its outside skin and to the center lines of the upstairs partitions. It is chosen because into it, with one standard detail, can be fitted commercial steel casement windows, standard thermopane, and doors. For the whole house only two sizes of thermopane are used, only one standard steel casement, and only one size door. There is only one exception -- the faculty bath and bedroom windows which open out of the bottom floor uphill. Standard basement type steel casements are used here. This standardization of detail and part produce a valuable economy, particularly when the apply to a whole group of buildings.

The interior finish of the bedrooms upstairs will be exposed rafters and sheathing overhead, either plywood or some wood composition board for the walls, and an asphalt tile floor. They are simple, dry, relatively inexpensive materials. There is a compromise on maintenance economy whenever a malleable and nailable surface material is used. The walls and ceiling can either be painted or coated with stains, clear
or otherwise, thus furthering the possibility of variety. The aspect of the rooms so finished will be of a rought neatness. The aspect of the whole house will, I believe, be neat but rough. It is surrounded by rough country and the people who live in it should be neat.

The interior finish of the downstairs is to be of the exposed masonry block. I am considering using twelve-inch thick walls on the outside and eight-inch walls for the inside. The twelve-inch exterior walls may be either solid or cavity walls depending on whether they are exposed or dig in quite deeply. If they are dug in, strength requirements would quite probably rule out the cavity wall. At the same time, however, it would lessen the need to reduce heat transfer. Where the strength requirements are less, the need to reduce heat transfer is greater because the wall is out of the ground. The block I had my mind on is a very rough dark grey light-weight cinderblock. I chose it for two reasons. The first is that I think its warm texture will be very appropriate, and the second is that it provides much better thermal insulation than the heavier blocks. The downstairs floor will be an asphalt tile on a concrete slab and the ceiling finish will again be a plywood or wood composition board which can be painted or stained like the ones in the upper part of the house. I propose that the colors of these finished materials be coordinated with the colors on the outside of the house and with the salient characteristics of the site. Perhaps, if the school wishes, the block can be painted.
There are two plexiglas skydomes in the roof over the up-
stairs hallway. They are there for two reasons. One is so
that there will be some natural light in the hall which is
cut off from the outside walls of the house by the rooms.
The other reason is so that a beam of sunlight will go
down the stairwell and either shine on the floor at the bot-
tom or shine on the wall beside the stairs. This will, of
course, only happen at certain times of day. The effect
on the student living room below a well daylit stairwell
will I think be immensly cheering.

In the faculty living room I was able to squeeze a fireplace
in because it had its back to the furnace room and the chim-
ney was already there. The chimney comes down into the living
room and the hearth is beside it. A metal hood will act as
both smoke collector and smoke chamber. The inclusion of
the fireplace, I feel, is a great fortune for here we have
a magnet with which to draw the students into the faculty
living area. It will now be really possible for the faculty
to have a place to invite students which is cozier and more
intimate than the students' own living room. I do not expect
all the students at once in the smaller room, but it is just
the sort of place to have two or three come in and have in-
timate talks and so on. They can have tea and sit by the
fire when it is blowing fiercely outside and work up a good
rapport. Nothing could be more instrumental to the school's
wishes.
More complete information about the materials used in the building is found in the technical information section, where I have explained the materials which have a technical basis rather than an aesthetic basis.
SPECIFICATION IN BRIEF OF MATERIALS

Footings - concrete
First floor walls - cinder block
Structure - wood beams, posts, and 2 x 4s.
Roof - plywood sheathing covered by insulation board and
topped by a built-up roof.
Second story walls - Composition board sheathing covered
by either boards and battens or plywood, either plain
or striated, or tongue and grooved boards.
Floors - asphalt tile over either plywood sheathing or con-
crete.
Interior partitions - plywood or wood composition board.
   Tongue and groove boards also possible.
Insulation - reflective aluminum foil insulation.
Outside doors - wood framed glass doors.
Inside doors - hollow core flush wood doors.
Operating sash - steel casements such as Hopes "Holford".
Fixed glass - either standard thermopane or polished plate.
Bathroom floors - ceramic tile.
First floor ceilings - plywood or wood composition board.
Design of Radiator for Upstairs Rooms

[Reference - Severns and Fellows -- Heating, Ventilating and Air Conditioning Fundamentals]

Design Conditions

inside design temperature - 70°F
outside design temperature - 10°F
two air changes per hour assumed to cover leakage

Surface Coefficients

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<thead>
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<th>U</th>
<th>Reference</th>
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<td>[Arch. Graphic Standards]</td>
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<tr>
<td>Wall and Floor</td>
<td>0.16</td>
<td>[See Attached Sheet for Calculations]</td>
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</table>

Heat Loss Through Surfaces

\[ H = AU [T_2 - T_1] \]

Heat Loss Due to Air Change

\[ H = 0.24 \times 0.075 Q [T_2 - T_1] \]

Side Room

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<th>BTU/HR</th>
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<td>floor</td>
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<td>glass</td>
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\[ 1350 \text{ ft}³ \times 2 \times 80 \times 0.24 \times 0.075 = \frac{3900}{84.20} \text{ BTU/HR} \]
Corner Room

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<th>4520</th>
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1570 x 2 x 80 x .24 x 0.75 = 4520

The Heating Element

EDR of 1 1/4" finned tube = 4 1/4 sq ft/ft of length
Effective length of double tiered tube = 1.8 x length of single tube

Correction factor for above standard operation of 205°F water temperature

\[
\frac{205-70}{170-70}^{1.3} = 1.35^{1.3} = 1.5
\]

Heat transfer

\[
H = EDR \times 1.5 \times 150 \text{ BTU/HR} - \text{ft}^2 \times \text{effective length}
\]

\[
H = 4 \ 1/4 \times 1.5 \times 150 \times 1.8 \times 6 = 10,300 \text{ BTU/HR}
\]

Use double tier 6' long of 1 1/4" finned tube far side room.

In corner room use 9' feet of double tier 1 1/4" finned tube radiator

\[
H = 4 \ 1/4 \times 1.5 \times 150 \times 1.8 \times 9 = 15,450 \text{ BTU/HR}
\]
Estimate of Total Max. Heat Load and Boiler Capacity

Design Conditions Same as for Upstairs Rooms

Surface Coefficients

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<td>block</td>
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<td>.16</td>
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Heat Loss Through Surfaces

\[ H = UA (T_2 - T_1) \]

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</tr>
<tr>
<td>wall</td>
<td>748</td>
<td>.16</td>
<td>80</td>
<td>9600</td>
</tr>
</tbody>
</table>

Volume = 22,800 ft³

Total Heat Loss = 150,250 BTU/hr

Hot Water Capacity of Boiler [for showers etc.]

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 showers x 200 gal/hr</td>
<td>800 gal/hr (Arch. Graphic Stand.)</td>
</tr>
<tr>
<td>7 basins x 10 gal/hr</td>
<td>70 gal/hr (Arch Graphic Stand)</td>
</tr>
</tbody>
</table>

Heat Required to Heat Water

\[ H = Q \left( h_{f_2} - h_{f_1} \right) \]
\[ H = 870 \times 8.338 \times [117.9 - 8] = 80,000 \text{ BTU/HR} \]

[The enthalpy of water at 40°F = 8]

This is a tremendous extra load and one which occurs only once a day. I recommend a hot water storage capacity of 800 gallon and an added furnace capacity of only 20,000 BTU/HR.

A Factor of 1.2 is being used to cover pick-up loads in the mornings.

\[
150,250 \times 1.2 = 180,000
\]
\[
+ \frac{20,000}{200,000 \text{ BTU/HR capacity}}
\]

\[
\frac{200,000}{150} = 1330 \text{ ft sq EDR Standard Hot Water Capacity.}
\]

I wish to emphasize that these calculations are a rough estimate.
The Surface Coefficient for Outside Walls.

The frame wall

\[ U = \frac{1}{1.65 + \frac{1}{.25} + \frac{-.5}{.30} + \frac{1}{6.0}} = 0.16 \]

\( .25 \) is taken as the value of the reflective insulation

\( .5/.30 \) is the conductivity of the composition sheathing

Other surface materials are not counted because they will be of thin wood

The block wall

\[ U = \frac{1}{1.65 + \frac{8}{5.2} + \frac{1}{6.0} + \frac{1}{1.10}} = 0.32 \]

\( 8/5.2 \) is the conductivity of the blocks.

\( 1/1.10 \) is the conductivity of the cavity.
Design of the More Important Structural Members

Reference -- National Design Specification for Stress Grade Lumber

Loads

roof LL = 40 lb/ft$^2$
DL = 12 lb/ft$^2$ [7 + 5 from Arch. Graph. Stand.]

floor LL = 40 lb/ft$^2$
DL = 12 lb/ft$^2$ [7 + 5 from Arch. Graph. Stand.]

wall DL = 10 lb/ft$^3$ [estimated from Arch. Graph. Stand.]

Assume Wood has Following Properties:

\[ f = 1400 \text{ psi} \]
\[ c = 1200 \text{ psi} \]
\[ E = 1.6 \times 10^6 \text{ psi} \]

Posts at First Floor 3' o.c. 75" high

The Load

roof LL = 3 x 9 x 40 = 1080 lb.
floor LL = 3 x 8 x 40 = 960 lb.
roof DL = 3 x 9 x 12 = 324 lb.
floor DL = 3 x 8 x 12 = 288 lb.
wall DL = 3 x 7 x 10 = 210 lb.
\[
\frac{2862 \text{ lb.}}{\text{total axial load/post}}
\]

Post used is 3 x 4 (nominal)
\[ K = 0.702 \left( \frac{E}{c} \right)^{1/2} = 0.702 \left( \frac{1.6 \times 10^6}{12 \times 100} \right)^{1/2} = 0.702(0.133)^{1/2} 10^2 \]

\[ K = 25.3 \]

\[ L/d = 75/2.625 = 28.5 \]

L/d > K Therefore the following column formula applies

\[ P/A = \frac{0.329 E}{[L/d]^2} = \frac{0.329 \times 1.6 \times 10^6}{[28.5]^2} = 650 \]

\[ P = 650 \times 9.52 = 6200 \text{ lb.} \]

Post only carries 2862 lb. O.K.

**Roof Joists**  
16" o.c.  
Span L = 14'

LL + DL = 52 lb/ft²  
w = 16/12 x 52 = 70 lb/ft

\[ M = wL^2/8 = 70 \times 14 \times 14/8 = 1720 \text{ ft} - \text{ lb.} \]

\[ S = M/f = 1720 \times 12/1400 = 14.75 \text{ in}^3 \]

Use 2 x 8  
S = 15.3 in³

**Floor Joists**  
16" o.c.  
Span L = 12'

LL + DL = 52 lb/ft²  
w = 16/12 x 52 = 70 lb/ft

\[ M = wL^2/8 = 70 \times 144/8 = 1260 \text{ ft} - \text{ lb.} \]

\[ S = M/f = 1260 \times 12/1400 = 10.8 \text{ in}^3 \]

Use 2 x 8
Check of Floor Joists at Overhang

Point load at end of joist

Load from roof/ joist spacing = 70 \([14/2 + 2]\) = 630 lb.

Load from outside wall/joist spacing = 10x7x16/12 = 94 lb

Total load \(P = 724\) lb.

\[M = 724 \times 2 = 1446 \text{ ft} - \text{lb}\]

\[S = M/f = 1446 \times 12/1400 = 12.4\]

\(2 \times 8\) is O.K.

Ridge Pole Beam

Span = 12'

\[LL + DL = 52 \text{ lb/ft}^2\]

\[w = 52 \times 14 = 728 \text{ lb/ft}\]

\[M = wL^2/8 = 728 \times 144/8 = 13,100 \text{ ft} - \text{lb}.
\]

\[S = M/f = 12,100 \times 12/1400 = 112 \text{ in}^3\]

Use \(6 \times 12\) \(S = 121 \text{ in}^3\)

Overhangs

\[M_1 = wL^2/2\] (For cantilevered beam)

To produce equal moments \(M_1 = M\)

\[wL_1^2/2 = wL^2/8 \quad 4L_1^2 = L^2 \quad 2L_1 = L \quad L_1 = L/2\]

Overhang can be half of design span of beam if conditions are the same without exceeding strength of beam.
Roof Beam at Outside Wall

Span = 3'

Overhand is critical condition    L = 2'

\( w = 52 \left( \frac{14}{2} + 2 \right) = 468 \text{ lb/ft} \)

\( M = wL^2/2 = 468 \times 4/2 = 936 \text{ ft} - 16 \)

\( S = M/f = 936 \times 12/1400 = 8.1 \text{ in}^3 \)

The 4 x 6 which is being used is O.K.    \( S = 19.1 \text{ in}^3 \)

Interior Floor Beam

\( LL + DL = 52 \text{ lb/ft}^2 \)

\( w = 52 \times 12 = 624 \text{ lb/ft} \)

\( M = wL^2/8 = 624 \times 144/8 = 11,240 \text{ ft} - 1b \)

\( S = M/f = 11,240 \times 12/1400 = 96 \text{ in}^3 \)

Use 6 x 12        \( S = 121 \text{ in}^3 \)

Check Overhang of Beam    L = 2'

The point load at end of beam:

Load from roof = 52 x 4 x 14 = 2910 lb

Load from wall = 10 x 9 x 14 = 1260 lb

Total load \( P = \) 4170 lb.

\( M = PL = 4170 \times 2 = 8340 \text{ ft} - 1b \)

Distributed Load:

\( w = 52 \times 12 = 624 \text{ lb/ft} \)

\( M = wL^2/2 = 624 \times 4/2 = 1248 \text{ ft} - 1b \)

Total Moment = 9588 ft - 1b which is less than 11240 ft - 1b

6 x 12 is O.K.
Floor Beam at Outside Wall [check] \( L = 2' \)

Overhang is critical condition.

Point load at end:
Load from roof \( 52 \times 4 \times 9 = 1870 \text{ lb} \)
Load from wall \( 10 \times 7 \times 8 = 560 \text{ lb} \)
Total load \( P = 2430 \text{ lb} \).

\[ M = PL = 2430 \times 2 = 4860 \text{ ft-lb}. \]

Distributed Load:
\[ w = 52 \times 8 = 416 \text{ lb/ft} \]
\[ M = wL^2/2 = 416 \times 4/2 = 832 \text{ ft-lb}. \]
Total \( M = 5,692 \text{ ft-lb} \)
\[ S = M/f = 5692 \times 12/1400 = 49 \text{ in}^3 \]
\( 4 \times 12 \text{ is O.K.} \)

Check of Shear in Ridgepole Beam
\[ V = wL/2 = 728 \times 12/2 = 4360 \text{ lb}. \]
\[ H = 3/2 \times V/bh = 1.5 \times 4360/63.3 = 104 \text{ psi} \]
\( H_{\text{all.}} = 120 \text{ psi} \quad \text{beam is O.K.} \)