CONSTRUCTION PLANNING: RESIDENTIAL HOUSING BUILT WITH VOLUNTEER LABOR

By

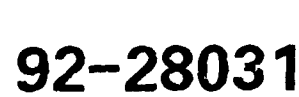
Michael J. Dolan

A report submitted in partial fulfillment
of the requirements for the degree of

Masters of Science in Civil Engineering

University of Washington

1992



CONSTRUCTION PLANNING:
RESIDENTIAL HOUSING BUILT WITH VOLUNTEER LABOR

By

Michael J. Dolan

A report submitted in partial fulfillment
of the requirements for the degree of

Masters of Science in Civil Engineering

University of Washington

1992

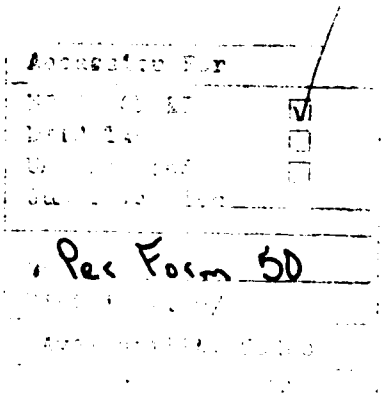


TABLE OF CONTENTS

LIST OF FIGURES

ACKNOWLEDGMENTS

I wishes to express sincere appreciation to Professor Charles T. Jarhen of the Department of Civil Engineering, University of Washington and Paul Nolan, Executive Director of Seattle Habitat for Humanity. Professor Jahren, serving as project committee chair, provide guidance and support throughout the research process, even finding time to hang sheetrock at the jobsite. Mr. Nolan cooperation in my research was excellent. Taking time from a busy schedule, he spent numerous hours discussing his organization and demonstrated a genuine interest in my research. I would also like to thank my wife, Sharon, for her support and special thanks to Professor Fred Mannering for serving as a member on the committee.

CHAPTER 1
INTRODUCTION

1.1 Schedules for Volunteer Construction

How can a schedule be developed when you can not count on the routine arrival of your labor, materials, or equipment? This is the dilemma that volunteer organizations involved in the construction of low-income residential housing must face daily. These organizations, such as Habitat for Humanity (HFH), can greatly benefit from proper construction scheduling. This report attempts to present a process whereby such construction organizations can quickly and easily develop useful construction schedules to increase project efficiency.

1.2 Traditional Schedules

The use of formal construction scheduling is found at most major construction sites. Considerable amount of material has been written on the subject of construction scheduling and leading texts (Coombes 1990, Reiner 1981) agree that a properly prepared schedule can:

* Provide a defined set of goals that can be worked towards and monitored for progress.
* Provide a checklist of activities to ensure that important details are not overlooked.

* Provide a time table for start and finish of specific activities.
* Convince participants that the project is organized and directed by competent leaders.

Unfortunately, these publications are directed towards professional methods of construction management and do not consider the unique limitations that volunteer organizations must contend with. Volunteer organizations have special constraints that must be considered, including the requirement to motivate the volunteer workforce, the uncertainty of material delivery, and the low skill level of the volunteer participants. The traditional scheduling process must be modified to satisfy the requirements of the volunteer organization.

1.3. Objective

The first step in developing a useful plan is to define the needs of a volunteer construction organization. This report focused on two main objectives:

1. Provide a plan that can be utilized at management level to track construction process and to plan for future needs.
2. Limit the complexity of the plan so that it can be used in the field as a tool to instruct and motivate volunteers.

It should be noted that for any schedule to be effective, it must have the input and support of the people that will be using it. For an effective field schedule to work, the on-site job leaders must be involved or the schedule will be meaningless. This also applies to the involvement of management in developing its schedules. Plans prepared by outsiders without the input from volunteers will normally be regarded as a threat and not as a tool. The following planning techniques were prepared with

the intent that volunteer organization could prepare the plans with little or no outside help.

CHAPTER 2
HABITAT FOR HUMANITY

2.1 Introduction

One of the best known of the volunteer construction organizations in the United States is Habitat for Humanity (HFH). Founded in 1976, HFH is an international ecumenical housing ministry that seeks to eliminate poverty housing. Through tax-deductible donations of money, materials and volunteer labor, HFH builds and rehabilitates homes with the help of the future homeowners. Houses are sold at no profit to families with no-interest mortgages issued over a fixed period. Currently, a HFH house in the U.S. costs homeowners $30,000, while overseas houses range from $1,000 to $3,000. Small monthly mortgages, including taxes and insurances, are repaid over an average of 20 years and deposited into a revolving "Fund for Humanity" which supports the construction of more houses.

HFH does not accept government money for construction of new houses, renovation or repairs of existing houses or general operating expenses of projects. However, HFH does accept funds for the development of streets, utilities, land, or old houses needing rehabilitation, providing those funds have no provisions attached that would violate HFH's principles.

A local family selection committee chooses homeowners based on their level of need, their willingness to become partners in the program (500 hours of "sweat equity" is required), and their ability to repay the loan. Every project follows a non-discriminatory policy of family selection,

neither race nor religion is a factor in choosing the families. Because of HFH's generous financing program and unique ability to involve the new homeowner and the community in each project, these new communities are extremely successful. According to HFH literature, the current default rate on HFH mortgages has been shown to be less than one percent nationally since the inception of the program 16 years ago.

There are over 600 affiliated projects in the United States, with more that 100 sponsored projects in 30 developing countries. In Washington State there are over 13 affiliates.

2.2 Seattle HFH

Locally, Seattle's HFH has constructed or rehabilitated 12 houses, with plans for construction of 14 new houses within the next five years (see Figure 2-1).

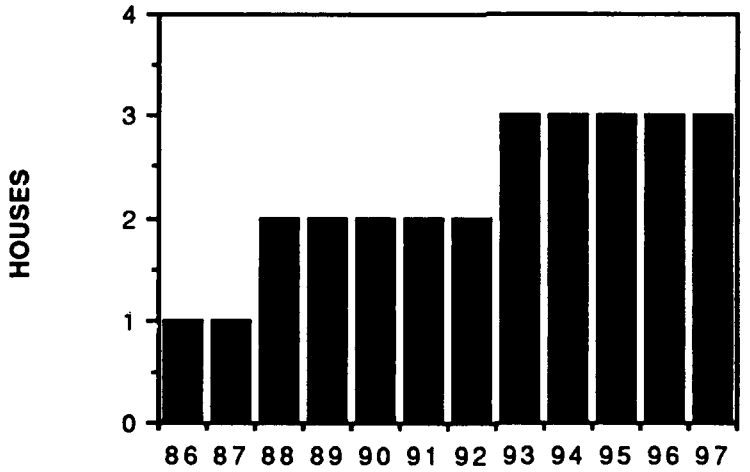


Figure 2-1
Housing Starts for Seattle's Habitat for Humanity

The most ambitious project for Seattle's HFH is the South Park Community Housing Project, located at 4th South and Concord. Five homes have been completed with the first of an additional 12 residences slated to begin construction during in the Fall of 1992. Approximately 2.6 acres of land will be developed during the next phase of construction. In addition to the dozen new homes, the South Park Community with feature roadways, landscaping and a community common area. Local architectural and engineering firms donated the required professional services in developing the layout and design of the community.

Seattle's HFH stresses that it does not just build houses, but attempts to build a strong community. This is done by rehabilitating existing homes, building new homes, and establishing a strong base for the community by selecting families that will stabilize it.

As an independent organization, Seattle HFH is responsible for their own fund-raising, publicity, volunteer recruitment and staffing. The international headquarters of HFH exists only to offer advice and assistance. In the local Seattle HFH chapter, there are seven committees that spearhead and direct these efforts.

2.3 Description of Committees

Construction Committee

The Construction Committee is responsible for the actual construction of HFH projects, and the coordination, training, scheduling and supervision of all persons who volunteer to work on HFH sites. This committee is also responsible for the selection, purchase or other acquisition, transportation and storage of all construction materials and supplies to be used on the homes.

Family Selection Committee

This committee is responsible for seeking out, screening, evaluating, and recommending to the Board of Directors potential purchasers of HFH projects, according to selection criteria adopted by the Board.

Finance Committee

This committee is responsible for all financial matters including, but not limited to, fiscal policies, credit application, budgets, financial statements, audits and taxes.

Fund Raising Committee

The Fund Raising Committee is responsible for raising all funds needed for the work of HFH. Sources of funds include individual giving, church giving and support from foundations and corporations. Seeking and collecting donations of construction materials also falls under the responsibility of this committee.

Public Relation Committee

Responsible for the promoting the work of HFH by increasing awareness of and support for HFH projects and activities within the community. Also shall establish contacts for mutual support with other groups or organizations in the community which have compatible or similar purposes. Examples of committee projects include a bimonthly newsletter, media coverage of HFH projects, public service announcements and all promotional materials.

Site Selection Committee

This committee is responsible for locating, seeking out, or otherwise identifying potential properties for HFH projects. The Site Selection Committee also makes recommendations to the Board of Directors regarding the adoption of potential sites.

Volunteer Committee

The Volunteer Committee coordinates the work of all volunteers, both individuals and work parties. This committee must also track the interest and skills of volunteers in order to better utilize individual according to the needs of HFH. They also encourage, respond to, and direct all interested work parties from churches, businesses and service organizations.

2.4 Engineering and Design

Funding for design is limited. Most of the drawings are standard plans which are altered for each new site by the project superintendent. Since the budget is extremely limited, and most materials are donated, the only cost estimating that is done is the committee's rough estimate of historical costs with an escalation factor for inflation. The cost estimate is altered to reflect the effect of expected donations. Very little breakdown and analysis of the plans are done.

By using standard plans, costs are reduced. This similarity makes it easier for the volunteers to become familiar with the general plan. Most design changes are made during construction. If the house's recipient request the change, final approval is left to the volunteers in charge of the particular project. The decision is made based on their experience and the budget constraints.

2.5 Procurement-Services and Materials

Under the typical, traditional residential construction approach, one would subcontract certain aspects of the labor and specialty construction. When working with volunteers, it becomes the job of the Volunteer and

Fund Raising Committees to solicit commitments for donated materials, supplies and labor. If sufficient materials are not obtained, then they are purchased by HFH through the Finance Committee. In addition, the committee needs to know the skill level and the number of workers that can be expected. This typically is not possible, and certainly not consistent. At a minimum, a skilled person is sought to head up the project as construction superintendent.

2.6 HFH Operation Manuals

Each HFH affiliate receives a Operations Manual from the International Headquarters in Americus, Georgia. The chapter on construction contains only 11 single typed pages of material and is void of any information on construction schedules. However, there is an effort underway to publish a six volume Affiliate Operations Manual (AOM) by the end of 1992.

A preliminary draft copy of the AOM was obtained for this report. While the new Construction volume greatly expands on the topic of construction from the previous manual and contains over 100 pages, the topic of construction scheduling is only discussed in a few paragraphs (see Appendix A - HFH Operation Manual Section on Scheduling).

2.7 Current Practice

Currently, no formal or informal scheduling system is used on Seattle's HFH construction projects. Various reasons are cited for not using a schedule:

1. Construction schedules are not used in the construction of single family houses. It is not an industry practice.

2. The size of the workforce cannot be predicted.
3. The delivery time of materials cannot be predicted.
4. The skill level of the volunteers cannot be predicted. It is estimated that 90 percent of the people working have little or no construction experience.
5. Most of the HFH volunteers have never worked with a construction schedule, thus it is unlikely that they can interpret and use one.

A planning system is needed that can address these concerns of volunteer construction organizations. Once the benefits of proper planning are demonstrated, organizations such as HFH, will make construction planning a integral part of the construction process.

2.8 Summary

HFH is comprised of people with a variety of skills, allowing volunteers with different backgrounds to come together towards a common cause. The unpredictable nature of many of the resources makes the management of these projects a challenging task. The next step is to find what motivates the volunteers in these organizations and how planning can maintain that motivation and provide direction.

CHAPTER 3
BACKGROUND

3.1 Volunteer Motivation

In the United States, volunteer organizations such as HFH and its volunteers, are important for the continued growth and development of our communities As government budgets are reduced and federal and state programs are curtailed or even eliminated, volunteer organizations must step in to fill the gaps.

With the great demands placed on volunteers from work and family activities, the time that the volunteer donate to any organization is especially valuable. To properly coordinate volunteers, one must understand what motivates them. Eleven categories have been suggested (Lewis 1978) that may explain volunteer motivation:

1. Recognition. Achieving through other's extrinsic rewards.
2. Skill maintenance. Particularly expressed by individuals who have temporarily left paid employment.
3. Social needs. As expressed by interpersonal interaction, group identity, personal reinforcement and feedback.
4. Expectation of others. As a result of peer pressure, community pressure, influence of children or others.
5. Knowledge for its own sake. Learning as opposed to skill maintenance.
6. Loyalty to a cause. Volunteering because of a belief in the purpose of the organization.
7. Debt repayment. Showing a desire to repay by helping others

having similar experiences.

8 Martyr syndrome. Having a desire to draw attention to sacrifices through volunteer work.

9. Selfless desire to serve. Demonstrating a sense of putting goals of an organization above one's self.

10. Volunteering for credit. Earning credit from universities, colleges, or high schools.

11. Career rehearsal. Preparing for employment.

Lewis went on to point out that all volunteers: (1) had multiple reasons for volunteering, and (2) motives changed through time. It is extremely important for the project superintendent to understand the motives of the volunteers. By failing to properly understand the motives that brought the volunteer to the construction site, the superintendent runs the risk of alienating the volunteer and creating an even higher turnover rate at the project.

The reasons given for donating time varies from volunteer to volunteer. However, the underlaying basis appears to be the desire to perform useful work. To fully realize that objective, volunteer organizations must properly plan their projects.

3.2 Motivation, Morale, and Job Progress

There has always been a close association between motivation and job quality at a construction project. In their book, Volunteer Community, Eva Rainman and Ronald Lippitt discussed several specific concepts pertaining to volunteer motivation. The following are some ideas especially applicable to volunteer construction organizations:

1. To increase motivation, most volunteer opportunities should provide for both self-actualizating personal development and meaningful service to the needs of others. In other words, opportunities to learn and grow as well as opportunities to contribute one's tithe of social service.
2. A "contract" should be established between the volunteer and the organization. This informal agreement would legitimize a feasible level of commitment.
3. Much of the volunteers' sustaining and renewing motivation comes from seeing clear steps towards the group's goal, and successfully completing those steps, one by one.
4. And finally, motivation is best sustained if there are regular mechanisms for supportive feedback and recognition.

Volunteers are motivated by a commitment to get *the job done*, a desire to make a worthwhile contribution, a sense of pride in an organization, and a feeling of membership or belonging (Adult Education 1981). While construction volunteer organizations attempts to accomplish these goals, the overall effectiveness can be increased by the use of simple construction schedules.

Leadership and morale is often reflected in the quality of the project. Confident supervision, lack of confusion about what is happening, a minimum of conflicts between parties involved in the project, all have to do with creating an environment that makes it possible for people to do a better job faster, and making them to do it that way (Coombes 1990).

A review of current construction literature determined that traditional construction schedules were not normally used in the construction of houses but the authors went on to state that schedules

should be used (Coombes 1991, Reiner 1981). By laying out and maintaining a smooth progression of work, finding trouble spots before they happen and resolving problems quickly when they do happen, a construction plan can help create an attractive volunteer environment.

3.3 Planning and Scheduling Techniques

There are three basic steps to managing a construction project:

1. Planning: The construction process is broken down into separate, finite activities. Interrelationships and dependencies between activities are determined to allow sequencing of activities.
2. Scheduling: Once the logic sequencing of activities is completed, the duration of each activity is estimated and applied to the plan.
3. Monitoring: During construction, the schedule is used to coordinate activities, plan for requirements, and to monitor progress.

The following are two examples of common planning and scheduling techniques.

3.4 Bar Chart

One of the most widely used planning aids is the bar chart, also called a Gantt Chart. The bar chart indicates the times that activities will occur but does not show logical relationships between activities, for example, down the vertical axis are listed the activities, the horizontal axis is used to portray time. Usually, the resulting bar depicts the length of a particular activity.

A bar chart prepared for this report (see Appendix B - Example Bar Chart), shows the simplicity in its construction and the way it can

communicates information. The Bar chart is easy to develop and can be completed by hand or with the help of computer program software. This type of chart gives quick reference to the phasing of a project. In addition, an individual activity could be expanded into the detailed activities that make it up. The Bar chart can easily be used and maintained in the field.

The biggest drawback of the Bar chart is its failure to show interdependencies between activities. Volunteers would not be able to tell for example that rough plumbing must be completed prior to installing wall insulation and drywall.

It is interesting to note that the bar chart has been heralded as the quick and easy planning tool, however, it may not be appropriate for volunteer organizations. With the removal of time constraints, the effectiveness of the bar chart comes into question. Volunteer organizations can be sure of logic, but not time. A more complete scheduling tool is the network diagram.

3.5 Network Diagram

A Network diagram is a graphic representation of the project. The activities that make up the project are placed in logical order, from left to right, and connected. The critical path is the path through the project that requires the most time to finish, consisting of a series of steps which must occur in sequence. On the network diagram prepared for this report, (see Appendix C - Example Network Diagram), the critical path is highlighted. For a house the path is traced thorough earthwork, foundation, wall framing, roof, rough-ins, drywall, finishes and punchlist.

Modern computer scheduling programs can be used to produce a schedule that uses man-hours or man-days instead of traditional units of

time as days or weeks. This would produce a schedule that was dependent upon the effort put forth instead of workdays, thereby creating a plan that was not time dependent and would require little updating. Since most volunteers organizations do not concern themselves with a rigid time schedule, the tedious work of calculating early and late starts and finish dates can be eliminated.

To prepare a critical path network, the builder must first break down all construction into activities, just as it would have to be done for the bar chart. Next, interdependencies between activities are identified and a network drafted. This type of network would best be suited for Committee members to track progress and plan for future requirements.

3.6 Summary

Potentially helpful planning and scheduling techniques have been identified and are readily available. The next step is to develop a planning system for use by volunteer construction organizations.

CHAPTER 4
METHODOLOGY

4.1 Objective

This project's objective is to develop simple construction planning systems that would be beneficial in coordinating the efforts of volunteer construction organizations.

4.2 Summary

The method consisted of the following steps:

* Asses the extent to which construction schedules are used in volunteer construction organization.
* Identify unfilled planning and scheduling needs in volunteer construction organizations.
* Develop an appropriate scheduling system that would be useful to volunteer construction organizations.
* Review the proposed scheduling system with volunteer organizations.
* Modify the system.

4.3 Process

To investigate the use of construction schedules in volunteer organizations, on site interviews were conducted. Mr. George Lewis and Mr. Jeff Altschul, project superintendents on separate Seattle HFH's projects were interviewed along with Mr. Jon Affolter, supervisor of the smaller "Teramanto Community". Located between Issaquah and Renton,

Washington, "Tera" is a cooperative housing community that also relies on volunteer labor for the construction of its houses. In all three cases, no formal construction scheduling systems were found to be used.

Interviews conducted at the projects determined that the organizations were extremely informal and non-structured. No long term formal planning was observed and operations appeared to be organized from day to day. The majority of volunteers possessed little or no construction experience, with the exception of the project superintendent. It became readily apparent that the management of volunteer projects could be improved with a more formal planning system.

To that end, a planning system was developed by the author. Intermediate versions of the plan were reviewed by project superintendent Jeff Altschul and Professor Charles Jahren and their suggestions were incorporated into revised versions.

The final version of the planning system was once again presented to field personnel. They reviewed the system and provided additional suggestions for improvement and comments.

CHAPTER 5
THE PLANNING PROCEDURE

5.1 Introduction

For any project to run smoothly, a plan must be made and communicated. This proposed planning procedure is tailored to enhance communications among a group with limited time and construction experience. It provides necessary information for project coordination and ties this information to construction activities. The system was developed in response to the needs identified during interviews with volunteer construction supervisors.

5.2 Results of Interviews

The results of the interviews indicate that volunteer construction projects could be greatly improved by enhancing communication and coordination. Specific problems that are related to poor planning include: lack of tools brought to the site by volunteers; the failure to obtain permits and inspections in a timely manner; lack of materials on the site; and the improper sequencing of construction activities. Many of these problems could be avoided by better planning and communication.

One of the biggest complaints from the field is the lack of planning and coordination in the scheduling of permits and building inspections. Each of these activities are on the critical path and must be prepared for in advance. Since construction is limited to a few days a week, the failure to recognize the need of a permit or inspection can delay the project for weeks. A good construction schedule would signal the upcoming

administrative requirement in advance and could be scheduled not to conflict with job progress.

Not all field problems involve the coordination of building inspectors. Consider the following example related by a project superintendent:

The project was in the early stages of sheetrocking the interior of the house. That morning, more than one dozen volunteers had reported to work. Normal construction practice dictates that sheetrock should be fastened to the ceiling prior to placing drywall on the adjoining walls. However, only two step ladders were brought to the project that day. The result: As two workers used the ladders to place sections of drywall on the ceiling, ten other workers stood by. After a piece of ceiling sheetrock was in place, the remaining ten workers eagerly "swarmed" over the small section of the wall that was now ready. A job meant for two workers now had ten. The result was low productivity, frustrated volunteers, and low morale.

The problem could have been avoided with proper planning. The requirements for the drywall activity should have been reviewed the previous week and volunteers asked to bring ladders from home.

Traditionally, construction schedules are defined as a time management plan. Owners of a typical construction projects are very concerned that their projects are completed on-time and on-budget. The results of the interviews showed that the majority of HFH projects are more unpredictable and not as time dependent as commercial projects. Therefore, standard scheduling practices must be modified to meet HFH requirements. New families or "owners" are willing to accept delays in the completion of their new homes and are on no fixed timetable.

With the removal of time constraints in a construction schedule, the

process then becomes one of project planning, coordination, and monitoring. The success of the schedule then becomes its ability to convey these ideas to the volunteers.

5.3 Construction Activities

Every construction project can be broken down into activities. These activities represent sequences in work. The number of activities in a project is determined by the level of detail that is used. A small level of detail produces fewer number of activities. From these sets of activities, we can plan many things.

Activities are composed of specific needs that have to be planned for and met in a timely manner. To ensure a smooth running project, activity demands, such as, tools, construction skills, safety hazards, materials, and labor requirements, have to be known in advance.

Results of the interviews conducted, revealed that communication was a key consideration in running a more successful operation. Thus, one goal becomes relating activity demands, e.g. step ladders and razor knives, to the activity itself, i.e. drywall, in a way that can be readily understood by volunteers. How is this best done? The answer is with graphics.

5.4 Communication with Graphics

The graphic communication of a plan is more effective in a situation where the users have limited construction experience. In the construction of single residential houses, the process is made up of a series of standard activities. Every house must have a foundation, interior and exterior walls, a roof, and so forth. By developing these basic construction activities into graphical illustrations, the construction process becomes visual and more

tangible to the user. They become trademarks or symbols for the activity. Haig Townsend and Jennifer Mann, local architectural graduates, recently provided graphic representations of standard construction activities to the Seattle HFH chapter. The artists encouraged the use of their drawings for this project. Figure 5-1 illustrates four sample graphic representations of construction activities.

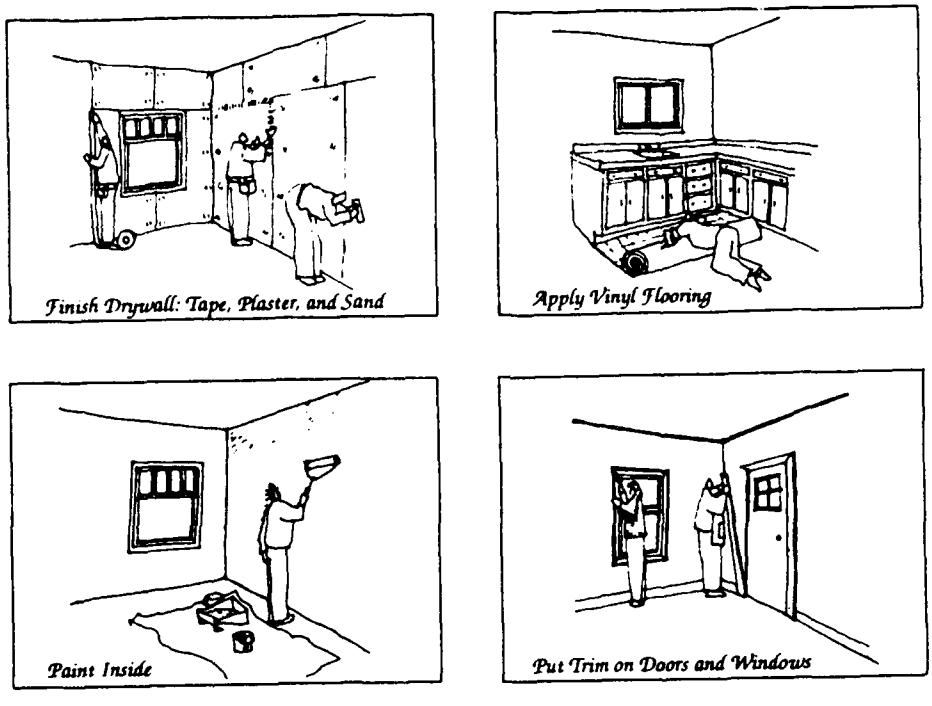


Figure 5-1

Sample Construction Activities

Drawn by Haig Townsend and Jennifer Mann

Most first time volunteers are not familiar with standard construction terms, such as drywall, footers, and trusses. By visually showing the process, again Figure 5-1, the volunteer can learn that drywall

is the material used to cover walls, and in addition, drywall requires taping, plastering, and sanding. In a matter of moments, the volunteer begins to better understand the activities associated with the construction of the house.

Construction activities should be broken down into simple steps, being careful not to present the volunteers with too much or too little detail. By developing an entire series of construction activity graphics, volunteers will be able to review the entire construction process at a glance. By using a set of graphics, (see Appendix D - Activity Cards), volunteers can set about developing logical sequence steps and laying out the groundwork for a construction plan.

These activity cards were constructed by cutting and glueing copies of the activities graphics to material cut from office file folders. Post-It's note sheets were attached to the backs of the cards to allow the cards to be displayed on a vertical surface. Similar to playing cards, these activity cards are easy to handle. Placed in plastic 35mm slide sheets, they are easily viewed and stored. The cards provide volunteers with a "hands on" opportunity to "construct" a house without ever picking up a hammer.

5.5 Activity Sheets

Having identified the activities, the graphics can now be used as a visual aid in developing activity summary sheets (see Appendix E - Activity Sheets). Completed by volunteers before the start of the project, these activity sheets would contain the graphic symbol for the activity on the front and vital information concerning the activity on the reverse side.

These activity sheets are modeled after Construction Activity Summary Sheets (CASS) used by Naval Construction Force Construction

Battalions (Naval CEC School 1988). Used as a planning device, CASS are intended to encourage the user to break the activities down into parts, such as, labor, material and equipment requirements, safety and environmental hazards, and quality control requirements. By completing the activity sheets in a timely manner, the volunteer would have a better understanding of the construction process. Alternatively, if volunteers prefer not to be involved with paperwork, a set could be prepared as a checklist and revised for each house.

Used in the field, the activity sheets would provide effective instruction to the volunteers on site. In the office, the activity sheets would be a planning device, allowing volunteers to review upcoming activities needs. Tools, materials, and inspections could be plan for in advance, reducing the risk of hindering construction progress.

These activity sheets can be sorted and stored in an accordion style folders and kept in the field and office. Current or future activity sheets would be pulled and displayed while completed activities would be replaced for safe keeping. Notations placed on completed activity sheets would serve as historical records.

A construction plan is built on a set of activities. Since the houses are standard and the activities are standard, once a plan is developed, it can be reused from house to house. Therefore, the activities and the activity sheets should be carefully developed.

Having now identified the activities and completed information sheets on each, the following questions can now be addressed:

* What activities are currently in progress?
* Which activities are in the future? and,
* How should we prepare for each activity?

The answer to each of these question can be found in a construction schedule.

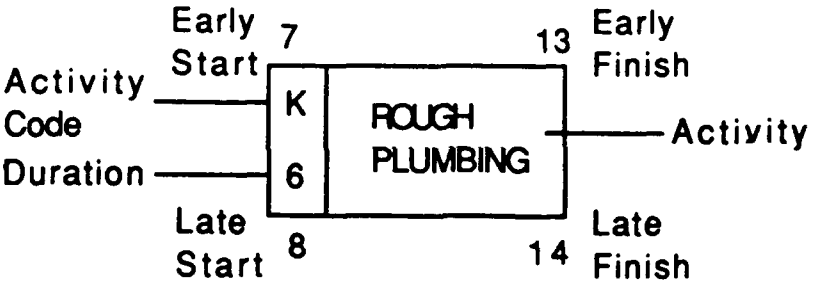
5.6 Cut and Paste Planning for Field Use

Using activity cards, volunteers can construct a construction process diagram. The example plan provided (see Appendix F - Graphic Construction Plan), was prepared in a matter of a few hours. The author used readily available office materials to construct the plan.

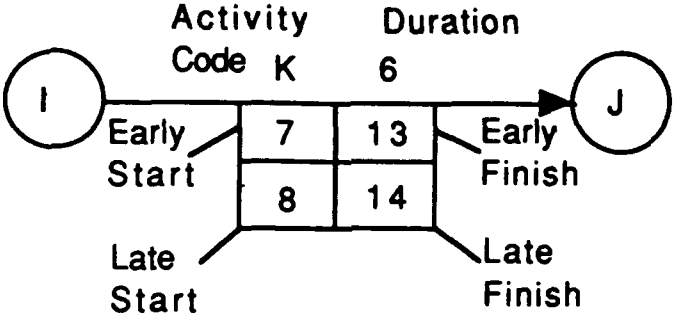
Computer paper was used because of its ability to fan-fold out. Activities cards were positioned on the computer paper in the order the author felt was a logical sequence in the construction of a house. Once the activities were in proper order, they were glued to the computer paper backing. The entire schedule was then glued to a stiffer paper board and sheets of clear laminating plastic were applied. The laminating paper was used to protect the schedule for use in the field. Lamination of the diagram also serves a dual purpose, as it can be used to record milestone dates and revisions using a grease pen.

Compared with traditional network diagrams (see Figure 5-2), the differences are readily apparent, and as the old maxim goes: A picture is worth a thousand words.

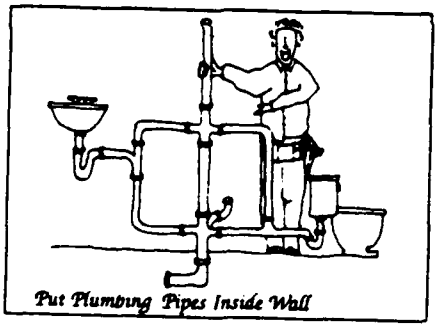
After the graphic schedule is completed, it would be maintained in the field and displayed in an area that could be seen by all volunteers. Prior to the start-up of the day's activities, the project foreman would review the schedule with the volunteers and discuss the day's activities. Activity sheets would be pulled from the file and safety, quality and other issues would be explained. New volunteers would also have the opportunity to review past activities and prepare for upcoming work.



(a)



(b)



(c)

Figure 5-2 (a) Activity on Node, (b) Activity on Arrow, (c) Graphic Activity

This graphic network schedule demonstrates the ease in which a planning system can be prepared without a background in computer software or formal construction management training. Ideally, a facilitator or a volunteer with construction experience, would assist the volunteers in preparing the schedule. As previously mentioned, it is essential that field personnel that will be involved in the actual construction of the project, e.g. project superintendents, are involved in the planning of the construction schedule.

Secondly, the schedule could be used as a display when volunteers lecture to the public on the merits of their program. By providing a well thought out schedule, a message would be projected that the organization has developed a plan and is in control of the construction process.

5.7 Lifecycle

Figure 5-3 describes the lifecycle of the graphic planning system. Once construction activity graphics have been prepared, they are incorporated into both activity sheets and the construction plan.

Activity sheets are prepared using graphics and written instruction concerning the activity. These activity sheets can then be mailed out in advance to volunteers. Using the activity sheets, volunteers could prepare for the next day of work. The sheets would also be sent to the project for reference and instruction. Problems encountered during an activity is noted on the activity sheet and at the end of the project, the activity sheets are returned to the main office and revisions are made.

The second path of the activity graphics is the construction planning process. Using activity cards, a construction plan is prepared. A copy of

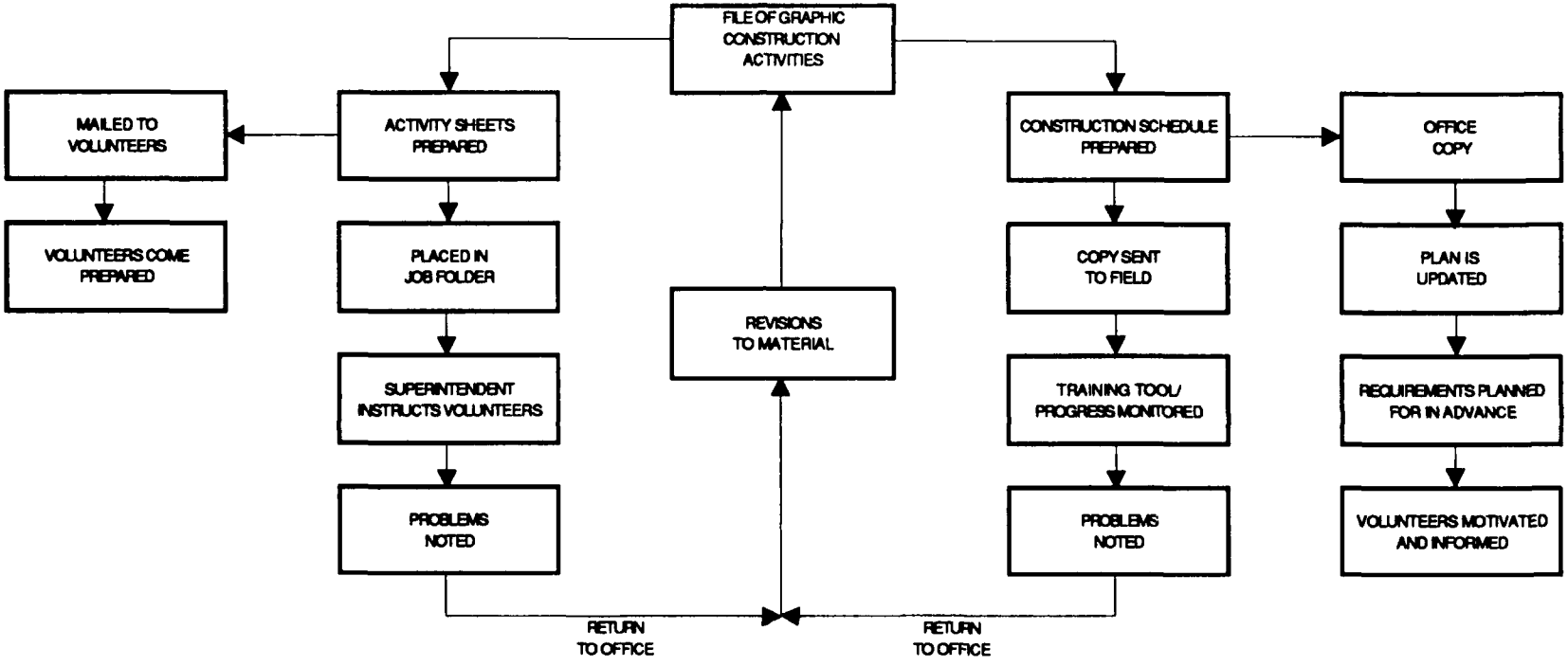


FIGURE 5-3: FLOWCHART OF CONSTRUCTION GRAPHICS

the plan is sent to any participating volunteer organizations for their use. It is updated by their volunteers and serves to keep them informed and motivated. Job requirements are planned for in advance and communicated to responsible parties. A second copy of the plan is sent to the project to monitor progress and to serve as a training tool. As with the activity sheets, problems and comments are recorded and at the end of the project, the plan is returned to the main office for final revisions.

Since projects and activities are standard, the process is refined every time a house is completed. Past problems and successes are reviewed and appropriate changes made to the process.

5.8 Summary

The potential usefulness of graphics in planning construction for volunteer organizations is readily apparent. Graphics has the ability to be used in almost every area of volunteer construction planning.

CHAPTER 6
CONCLUSIONS

A planning system has been developed that is appropriate for volunteer construction organizations. This system would give the volunteers a clear sense of the project's direction and goal. Using this knowledge, volunteers would have the opportunity to participate in problem solving and decision making. No longer would progress be hampered by the fact that volunteers are left in the dark with regard to the construction plan, they would have the opportunity to set new goals and see milestones successfully completed.

Part of a volunteer's motivation comes from seeing clear steps towards the groups goal, and from successfully completing those steps, one by one. The use of a activity sheets and networks that graphically depicts activities would provide the volunteers with an opportunity to review goals and allow the volunteers the satisfaction of seeing both short-term and long-term goals completed.

On the practical side, scheduling is an exercise in discipline, encouraging project leaders to plan the project prior to the start of construction. Interrelationships between activities would be established and the requirements for material, permits, and labor could more easily be planned and monitored.

Which scheduling system is the best for volunteer construction organizations? The simplest schedule that gets the job done. One that communicates clearly with pictures and provides essential information

CHAPTER 7
RECOMMENDATIONS

The question then becomes: Should volunteer construction organizations develop and maintain construction schedules? Absolutely! The primary reason for developing a well constructed schedule is to produce a product more efficiently, thereby, saving money, material, time and labor. A plan can provide information that aids in making decisions in planning, scheduling and controlling the project. The bottom line would be to get a family into their new home faster and for the least cost.

The considerations and actions recommended in this report are by no means the ultimate solution. HFH and other volunteer construction organizations are noble and worthwhile causes. They should be supported on all fronts. By continuing to review the process and refine the solutions, they can better make use of their limited resources. As such, the following recommendations are submitted:

1. Develop and foster a working relationship between volunteer construction organizations and educational institutions.
2. Encourage students in construction related programs to work closely with volunteer organizations. Scheduling and estimating could be made into class projects.
3. Produce a video tape on simple aspects of housing construction. The tape would cover topics such as tool use, simple framing, electrical, plumbing, roofing, etc. This tape would be used as a training film for volunteers and reduce the learning curve on the jobsite.

4. Recruit support from local trade unions. Union apprentices could train at a HFH project.
5. Contact local Contractors associations for support and donations of excess materials.
6. Contact local Construction Management firms and educational institutions for support. Professional CM's may be willing to donate time to help schedule projects and train personnel on proper scheduling techniques.
7. Task Navy civil engineering graduate students to investigate the possibility of using the local reserve Construction Battalion (SeaBees) to provide construction support on their training weekends.

While this report concentrated on the efforts of the Seattle HFH affiliate, the items discussed in this paper can be applied to many other non-traditional construction organization that have not developed a satisfactory scheduling system. Civic action organizations, such as the Navy's Civic Action Teams (CAT) and the Peace Corps, could benefit from the scheduling techniques presented.

BIBLIOGRAPHY

BOOKS

1. Affiliate Operations Manual, Habitat for Humanity, Americus, Georgia 1988.

3. Benson, Ben: Critical Path Methods in Building Construction Prentice-Hall Inc., 1970

2. Coombes, Jim: Real World Construction Scheduling Seattle: Frontier Publishing, 1990.

4. Construction Battalion Operations Student Guide Naval School Civil Engineer Corps Officers, 1988.

5. Fuller, Millard: No More Shacks! World Book Publisher, 1986

6. Ilsley, Paul: Recruiting and Training Volunteers, McGraw-Hill New York, 1981

7. Manage People, Not Personnel, Harvard Business Review, 1990

8. Naylor H. H.: Volunteers Today Association Press, New York, 1967.

9. Reiner Laurence E.: Methods and Materials of Residential Construction Prentice-Hall Inc., 1981.

10. Safety and Health Requirements US Army Corps of Engineers Manual 1987

11. Seabee Planners and Estimator's Handbook NAVFAC P-405 Department of the Navy, 1983

12. Walton, Mary: Deming Management at Work, Perigee Books, New York, 1991

13. Willis, Edward M.: Schedule Construction Projects John Wiley Sons 1986

APPENDIX A

The following information on scheduling is from the HFH's Affiliate Operations Manual, Volume V, Construction. These sections represents the written instruction given to affiliates on the use and benefits of construction scheduling.

Many scheduling methods are used in the construction industry, including computer applications. The two most practical diagrams for manual or computer use are the critical path method and the bar chart method.

The Critical Path Method (CPM) is a management tool that provides the Building Committee with a precise planning and scheduling technique by graphically showing each activity in a project ant its relationship in time to the other activities. A critical path provides an accurate picture of where the project stands, what remains to be done, and which jobs are critical for finishing tasks before starting new tasks.

CPM is a logical and organized planning system that encourages decisions but does not make them. The preparation of the diagram enables the Building Committee to view the project through the various activities to completion.
To produce an accurate and effective CPM schedule, the Construction Coordinator should include in the schedule diagram:

- Major contractors and subcontractors
- planned volunteer activities
- Homeowner's activities and contributions
- In-kind donations
- Materials to be purchased

Obtaining an approximate time for contractors and subcontractors to perform their tasks allows the use of volunteer labor and the homeowner to supplement the tasks they can perform. These tasks are then outlined, defined, and integrated into the total schedule.

The Bar Chart Method, the more basic of the two scheduling methods, puts the construction activity of the project into a calendar format. Each activity indicates when the tasks are to be performed. The biggest

advantage of a bar chart is its simple visual presentation. When an activity begins and ends, it is easily seen and understood by volunteers, homeowners, and others who are scheduled to perform a task. Unfortunately, the weakness of the bar chart schedule is that it cannot show the complex interdependence between various overlapping activities.

After the Building Committee has the building plans, they should request the CPM of bar chart for the house to be built. Less effort is needed when a written schedule organizes the work sequences. Scheduling can:

- Help to stabilize the cycles typical to the construction industry by reducing slack time and increasing overall productivity.

- Alleviate problems of crews with insufficient work.

-Provide options when unexpected delays occur due to equipment breakdown, bad weather, or when the crew simply falls off.

Formal preparation of a schedule includes three distinct phases:

1. Planning: Different activities are broken out and their relationship to one another are determined.

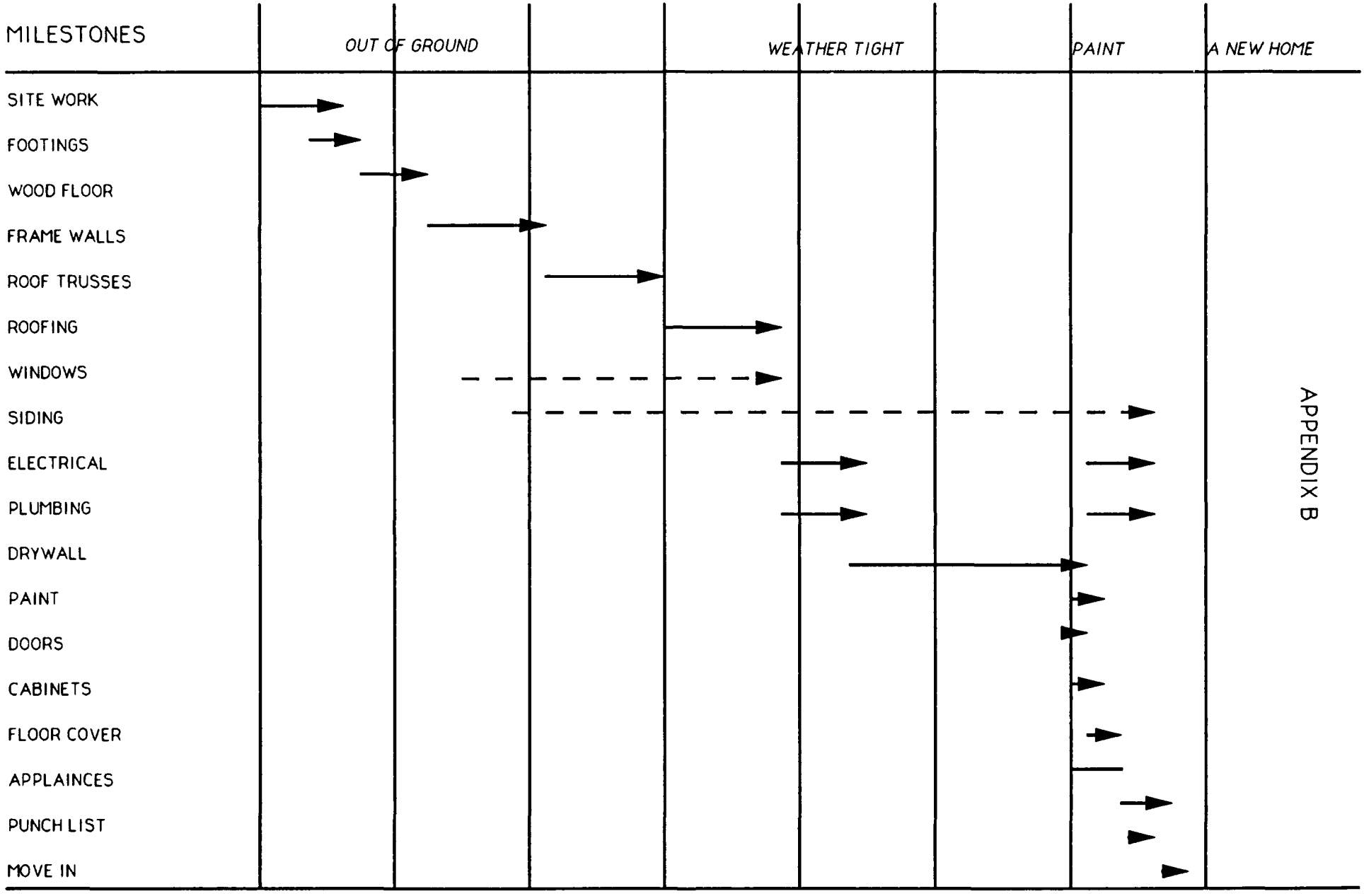
2. Scheduling: Time required to perform each activity is determined, and those activities with slack time are determined.

3. Monitoring: The foreman or crew leader uses the written schedule to organize the execution of each task.

Many affiliates work on a project monthly or weekly. Establishing a regular schedule of intervals between four and eight weeks prevents the risk of burnout and losing the crew. If the crew isn't scheduled to return more frequently than eight weeks, members tend to forget the the previously learned information, and their normal life routine interferes with their returning to the project.

APPENDIX B

EXAMPLE BAR CHART

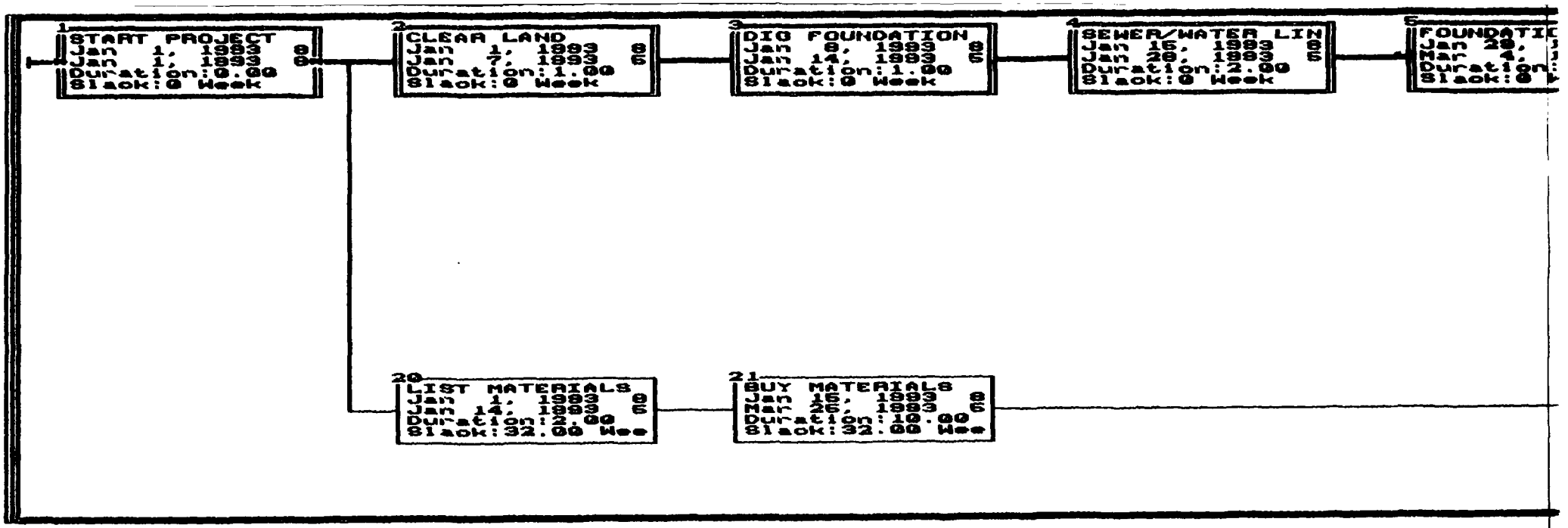


BAR CHART FOR A HFH HOUSE

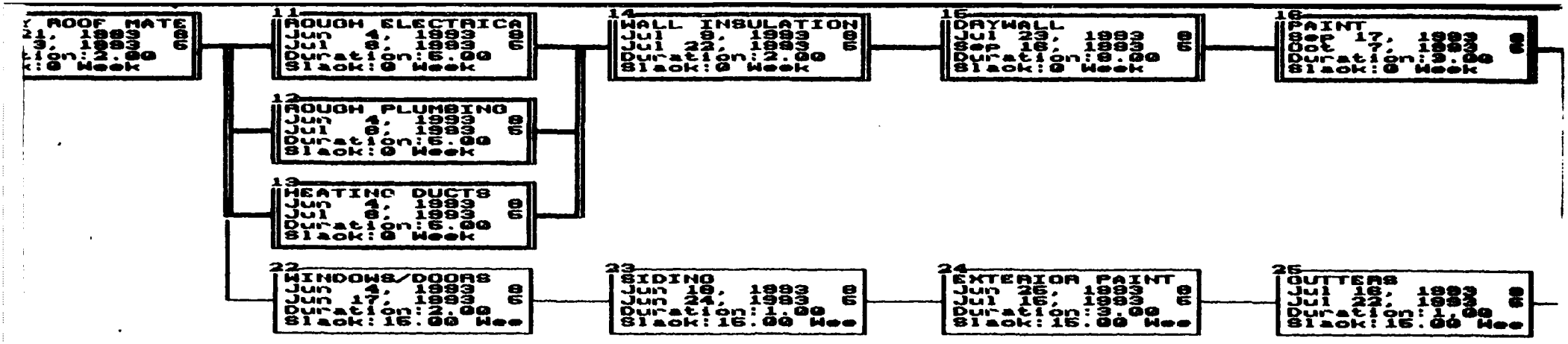
APPENDIX B

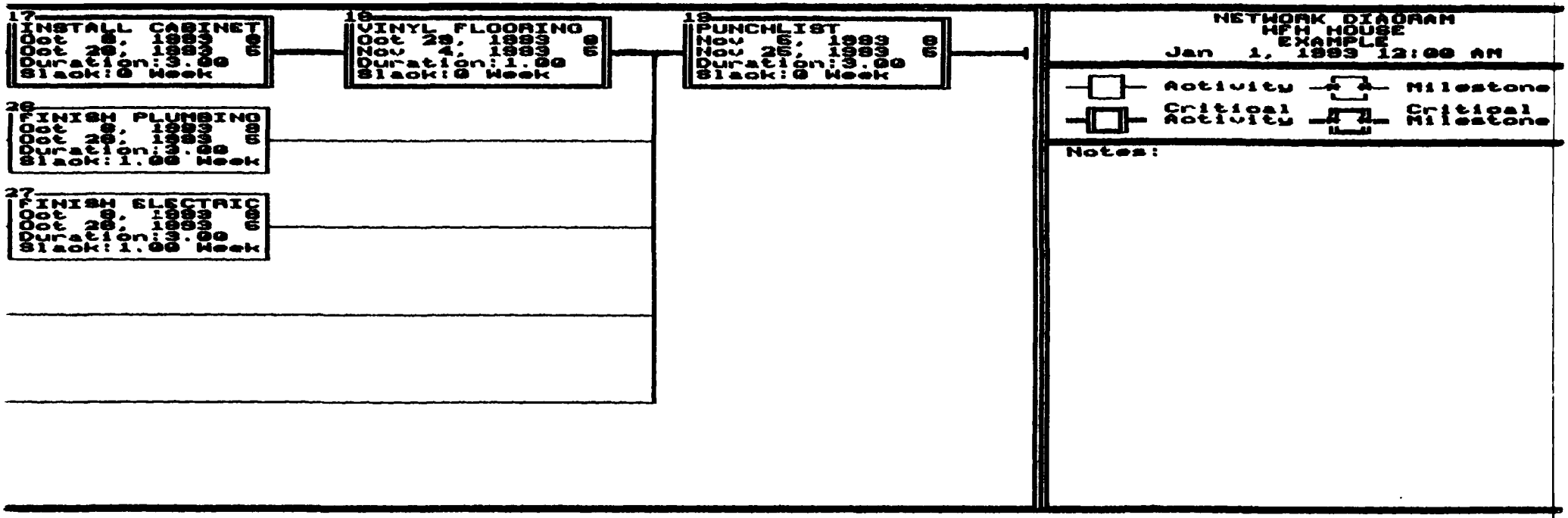
APPENDIX C

EXAMPLE NETWORK DIAGRAM


1
START PROJECT
Jan 1, 1993 8
Jan 1, 1993 8
Duration:0.00
Slack:0 Week
2
CLEAR LAND
Jan 1, 1993 8
Jan 7, 1993 8
Duration:1.00
Slack:0 Week
3
DIG FOUNDATION
Jan 8, 1993 8
Jan 14, 1993 8
Duration:1.00
Slack:0 Week
4
SEWER/WATER LIN
Jan 15, 1993 8
Jan 28, 1993 8
Duration:2.00
Slack:0 Week
5
FOUNDATI
Jan 29,
Mar 4,
Duration
Slack:0
20
LIST MATERIALS
Jan 1, 1993 8
Jan 14, 1993 8
Duration:2.00
Slack:32.00 Wee
21
BUY MATERIALS
Jan 15, 1993 8
Mar 25, 1993 8
Duration:10.00
Slack:32.00 Wee


6
BUILD FLOOR
Mar 5, 1993
Mar 18, 1993
Duration:2.00
Slack:0 Week
7
EXTERIOR WALLS
Mar 19, 1993
Apr 9, 1993
Duration:3.00
Slack:0 Week
8
INTERIOR WALLS
Apr 9, 1993
Apr 29, 1993
Duration:3.00
Slack:0 Week
9
ROOF TRUSSES
Apr 30, 1993
May 20, 1993
Duration:3.00
Slack:0 Week


ROOF MATE
11
ROUGH ELECTRICA
Jun 4, 1993
Jul 8, 1993
Duration:5.00
Slack:0 Week
12
ROUGH PLUMBING
Jun 4, 1993
Jul 8, 1993
Duration:5.00
Slack:0 Week
13
HEATING DUCTS
Jun 4, 1993
Jul 8, 1993
Duration:5.00
Slack:0 Week
14
WALL INSULATION
Jul 8, 1993
Jul 22, 1993
Duration:2.00
Slack:0 Week
15
DRYWALL
Jul 23, 1993
Sep 16, 1993
Duration:8.00
Slack:0 Week
16
PAINT
Sep 17, 1993
Oct 7, 1993
Duration:3.00
Slack:0 Week
22
WINDOWS/DOORS
Jun 4, 1993
Jun 17, 1993
Duration:2.00
Slack:15.00 Wee
23
SIDING
Jun 18, 1993
Jun 24, 1993
Duration:1.00
Slack:15.00 Wee
24
EXTERIOR PAINT
Jun 25, 1993
Jul 16, 1993
Duration:3.00
Slack:15.00 Wee
25
GUTTERS
Jul 16, 1993
Jul 22, 1993
Duration:1.00
Slack:15.00 Wee

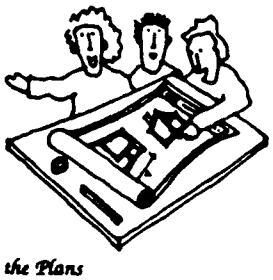

17
INSTALL CABINET
Oct 8, 1993
Oct 20, 1993 6
Duration:3.00
Slack:0 Week
18
VINYL FLOORING
Oct 28, 1993 0
Nov 4, 1993 6
Duration:1.00
Slack:0 Week
19
PUNCHLIST
Nov 6, 1993 0
Nov 26, 1993 6
Duration:3.00
Slack:0 Week
26
FINISH PLUMBING
Oct 8, 1993
Oct 20, 1993 6
Duration:3.00
Slack:1.00 Week
27
FINISH ELECTRIC
Oct 8, 1993
Oct 20, 1993 6
Duration:3.00
Slack:1.00 Week
NETWORK DIAGRAM
HFH HOUSE
EXAMPLE
Jan 1, 1993 12:00 AM
Activity
Milestone
Critical Activity
Critical Milestone
Notes:

APPENDIX D

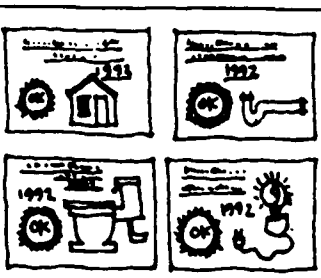
ACTIVITY CARDS
DRAWN BY HAIG TOWNSEND AND JENNIFER MANN

APPENDIX D

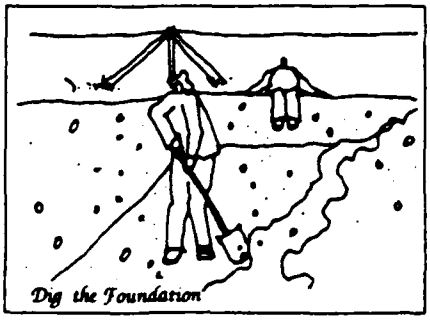
ACTIVITY CARDS



Draw the Plans

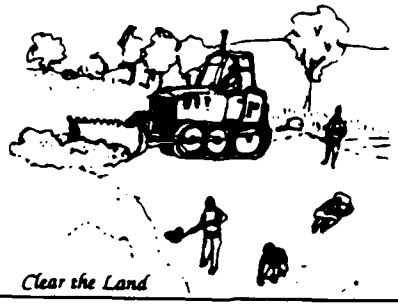


Get Building Permits

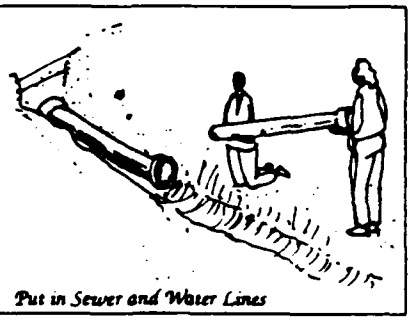


Dig the Foundation

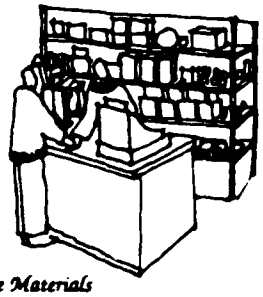
List the Materials



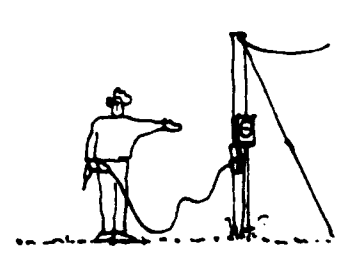
Clear the Land



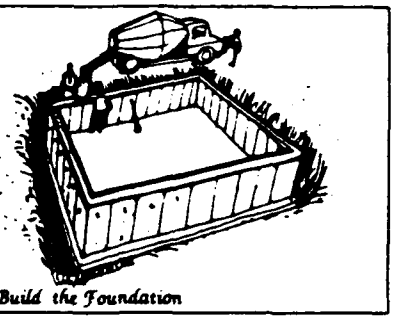
Put in Sewer and Water Lines



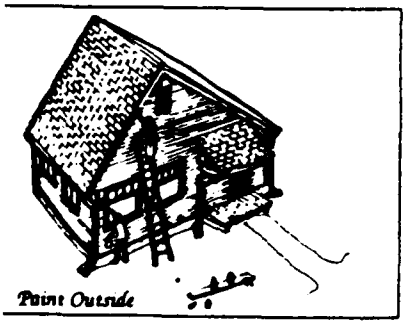
Buy the Materials



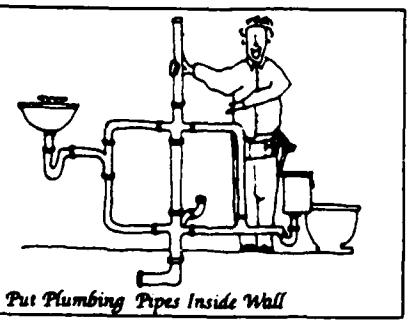
Get an Electrical Supply



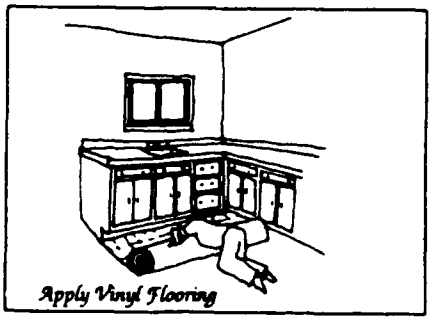
Build the Foundation



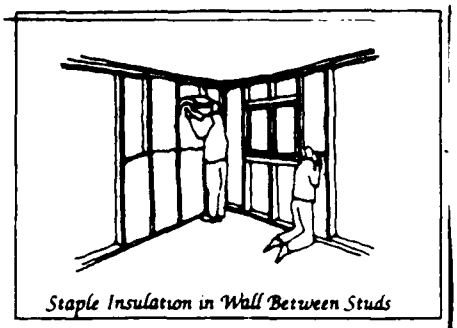
Paint Outside



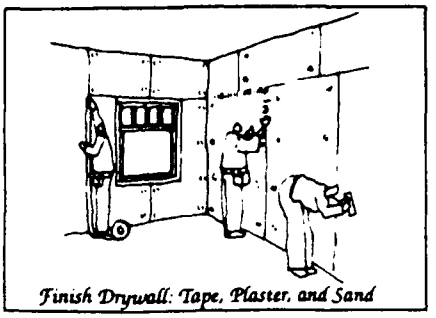
Put Plumbing Pipes Inside Wall



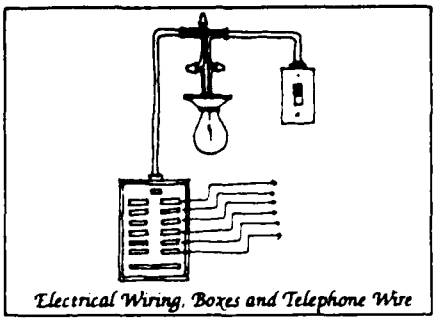
Apply Vinyl Flooring



Staple Insulation in Wall Between Studs

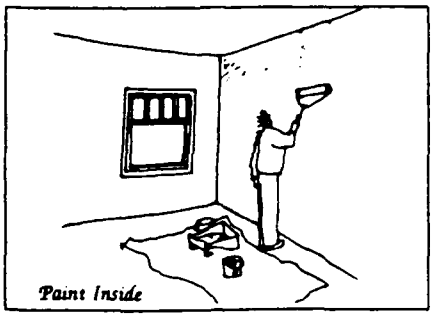


Finish Drywall: Tape, Plaster, and Sand

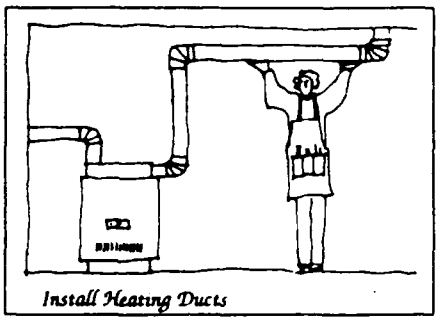


Electrical Wiring, Boxes and Telephone Wire

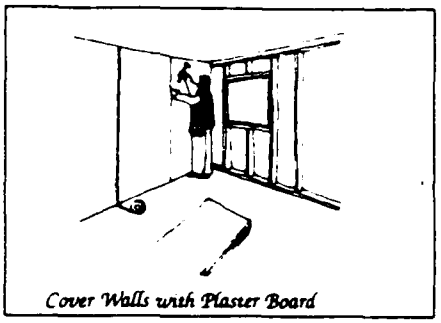
* Protect Your Skin When Handling Insulation: Wear Long Sleeves and Gloves



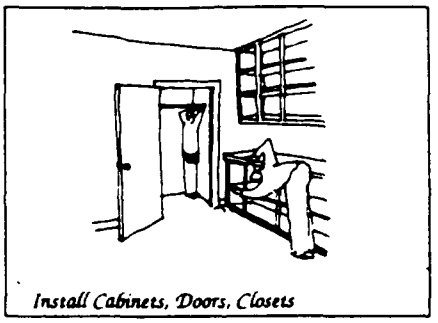
Paint Inside



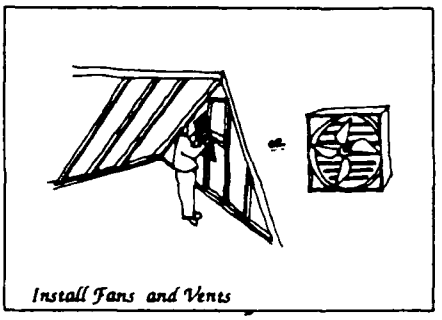
Install Heating Ducts



Cover Walls with Plaster Board

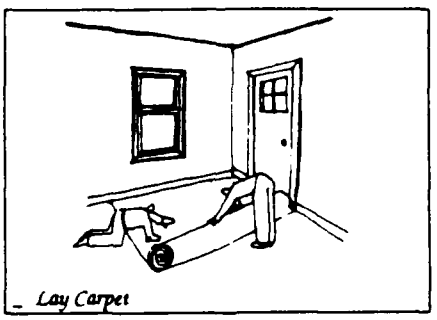


Install Cabinets, Doors, Closets

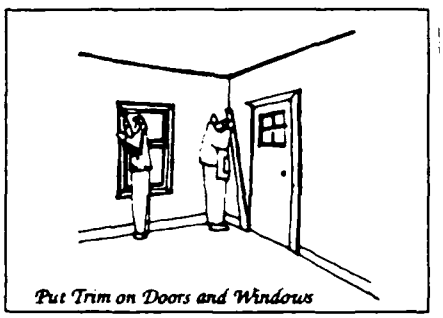


Install Fans and Vents

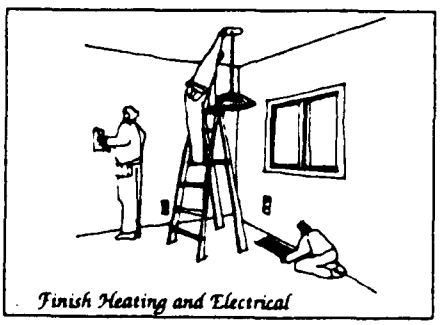
Finish Plumbing: Put in Sinks and Toilets



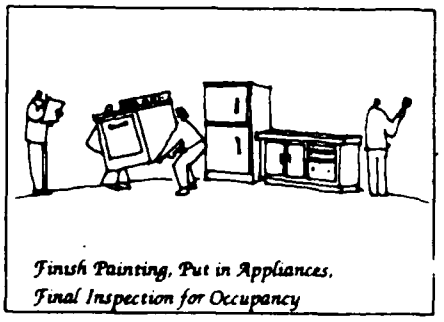
Lay Carpet



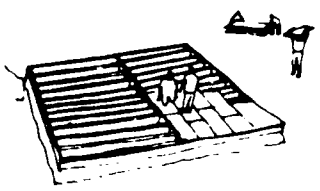
Put Trim on Doors and Windows



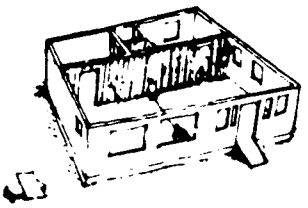
Finish Heating and Electrical



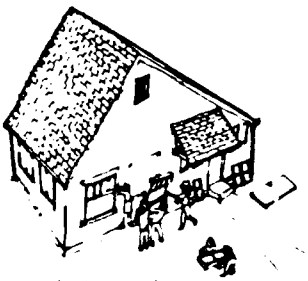
Finish Painting, Put in Appliances, Final Inspection for Occupancy



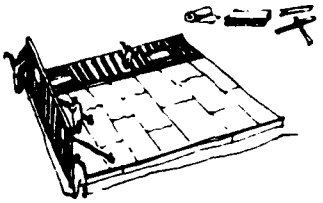
Build the Floor



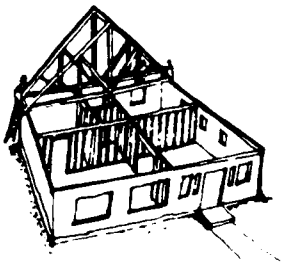
Layout and Build Inside Walls



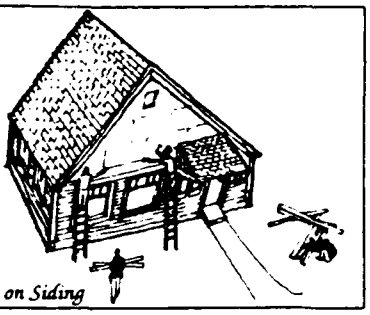
Put in Windows and Doors



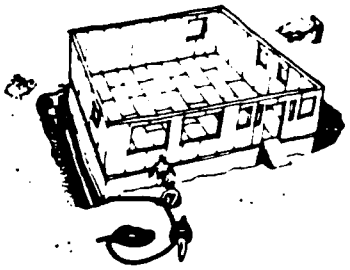
Layout 2x 6 Studs, Build and Raise Walls



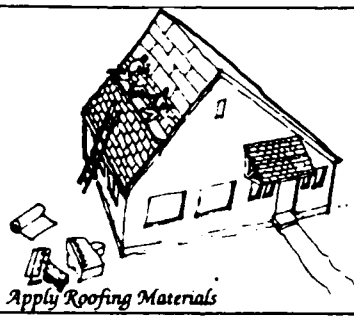
Put up the Roof Trusses



Put on Siding

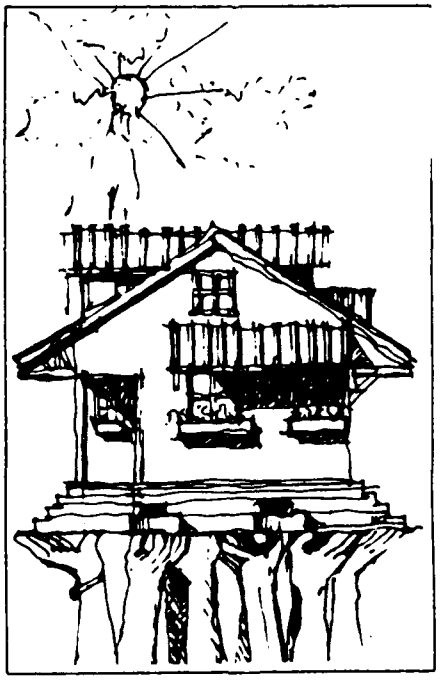


Install Footing, Drains, and Fill Holes



Apply Roofing Materials

Put on Gutters and Downspouts



ACTIVITY SUMMARY

Project Title: Habitat for Humanity

Activity Title: Framing

Safety:
Remove nails from boards before before discarding - don't bend them over
Safety glasses - required with all power tools
Hard hats when working under other or overhead
Don't hit two hammer faces together
Circular saw - do not restrict "off fall" - do not cut between two supports
Binding is a sign that something is wrong (dull blade, poor technique, etc.)

Tools:
Cats paw - softened steel
Use a block to pull nails with a hammer
Dry off a wet steel tape
Vertical snap chalk for a straight line

Materials:
16d sinkers - 2x lumber to 2x lumber
8d sinker - plywood to 2x lumber
1 1/4" roofing nails - sheathing to walls
Cut nails - lumber to block
Fluted nails - lumber to concrete

Techniques:
Set all nails heads below surface
Assemble elements flush - studs to plates - plate to plate
layout codes on the wall
2 16d nails per stud - bottom and top plate - one nail centered in cap plate above stud
Angle nails at end of studs for greater holding and to reduce splitting
Blunt nail tips to reduce splitting (when necessary)
Recognize and remove nails that miss - others use nail n=heads to guide their work
Keep nails separate in aprons and boxes
Check lumber for crown - apply to use (up on wall, and roof assembly)
Set aside bad (1/2" in 8") lumber for cutting into shorter lengths
Return nails to boxes at day's end or when changing nails
Don't skip a stud
Straighten crooked studs, joists, trusses or rafters to the edge of the sheathing
Approximately 1/16' space between sheathing
Space nails 6" to 8" on sheathing

ACTIVITY SUMMARY

Project Title: Habitat for Humanity

Activity Title: Sheetrock Hanging

Safety:
Have adequate support equipment
Keep sharp blades in knives - dull knives are dangerous
Keep square up off the floor

Tools:
Razor knife and extra blades
Hammers

Materials:
Green rock in bathrooms
Ringed nails

Techniques:
Mark locations of ceiling joists on the tcp plate before rocking ceiling
Mark locations of studs on ceiling (pencils) and floor (crayon) before rocking walls
Hold rock tight against ceiling for nailing
Hold top sheet tight against ceiling on walls
Hold bottom sheet tight against top sheet
1 pair of screws every foot across ceiling
1 nail every foot down walls
Do not over nail
Dimple nail without breaking paper
Keep nails and screws six inches away from receptacles and switches
Remove nails that miss and dimple the spot
Keep usable scrap organized
Don't pull fuzzies across paper- cut them

Layout Techniques:
Hang ceiling first
1/4" clearance at end of walls
1/8" clearance at opening (switch boxes)
Measure all layout mesurements from one end
Rock runs perpendicular to ceiling joists
Keep seams away from opening where possible - no seams in closets
Stagger joints in wall and ceiling
Run rock on walls horizontally
Locate seams in walls over and under doors and window where possible
Do not locate seams as edges of openings (doors - windows- boxes)

ACTIVITY SUMMARY

Project Title: Habitat for Humanity

Activity Title: Vinyl Siding

Safety:
Do not lift siding saw out of rack
Watch sharp aluminum edges on fascia

Tools:
Left and right handed snips
Crimping tool for undersill trim and quarter-round molding
Hole punch for making new slots
Nail set for installing small nails in tight spaces

Materials:
2" galvanized roofing nails for siding and accessories
White trim nails for fascia
Quarter-round molding for transition between siding and soffit

Techniques:
Allow 1/4" space for siding expansion - siding should be free to slide
Keep nails towards the center of the slots
Keep cut ends hidden behind door and window trim, corners or next piece
Watch sheathing for missing nails and bulges
Use balance from each row to start the next
Be sure that siding is locked into starter strip or previous row
Do not drive nails tight against siding (for expansion and contraction)

Run entire length of wall simultaneously
Check distance between new row and trusses as work progresses
Sight row - back nails out, as needed, to straighten siding
Use no piece shorter than 12", no seams within 4" of row below
Create a stagger in siding joints if necessary (24" or 36" wall)
Holding a piece in place for layout is more accurate than just measurements
Use scrap (under 12") to mock up difficult cuts
Check course alignment at corners
Check for ripples in fascia before nailing - nail every 2"
Keep soffit running perpendicular to facia - 1 nail per piece of soffit
Snap a line to install quarter-round molding
Extend corners 1/2" below starter strip
Adjust receptacles and light fixtures to rest on siding flats

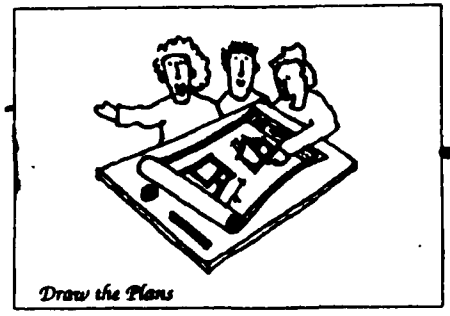
APPENDIX F

GRAPHIC CONSTRUCTION PLAN

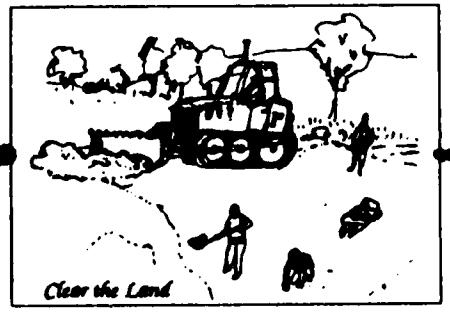
A SINGLE FAMILY RESIDENCE AT

OWNER: SEATTLE HABITAT FOR HUMANITY

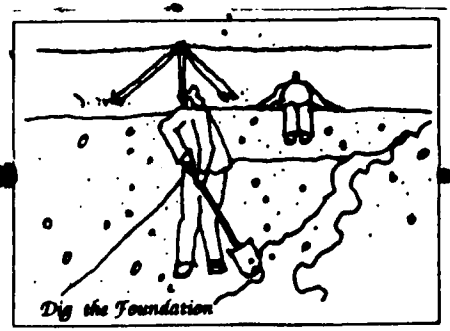
HABITAT NORTHWEST



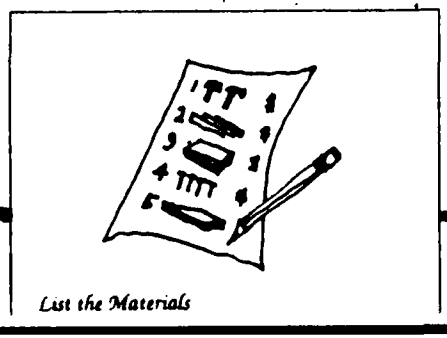
Draw the Plans



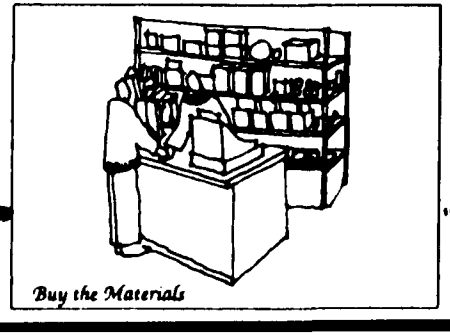
Clear the Land



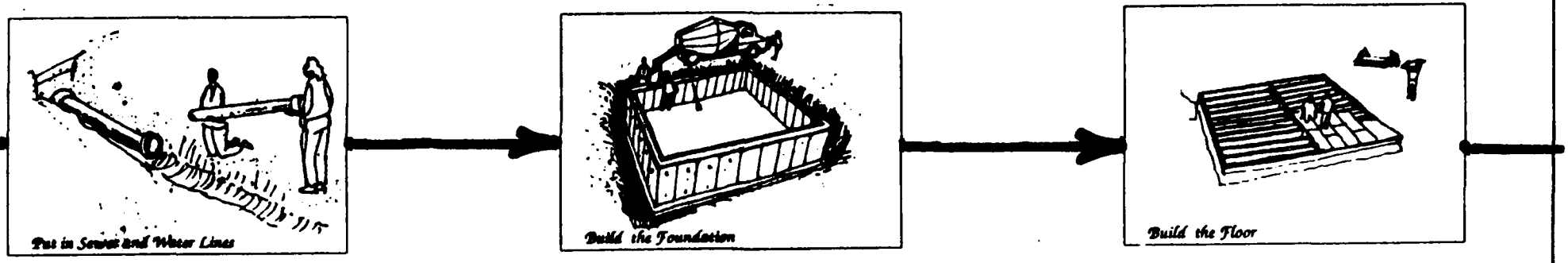
Dig the Foundation

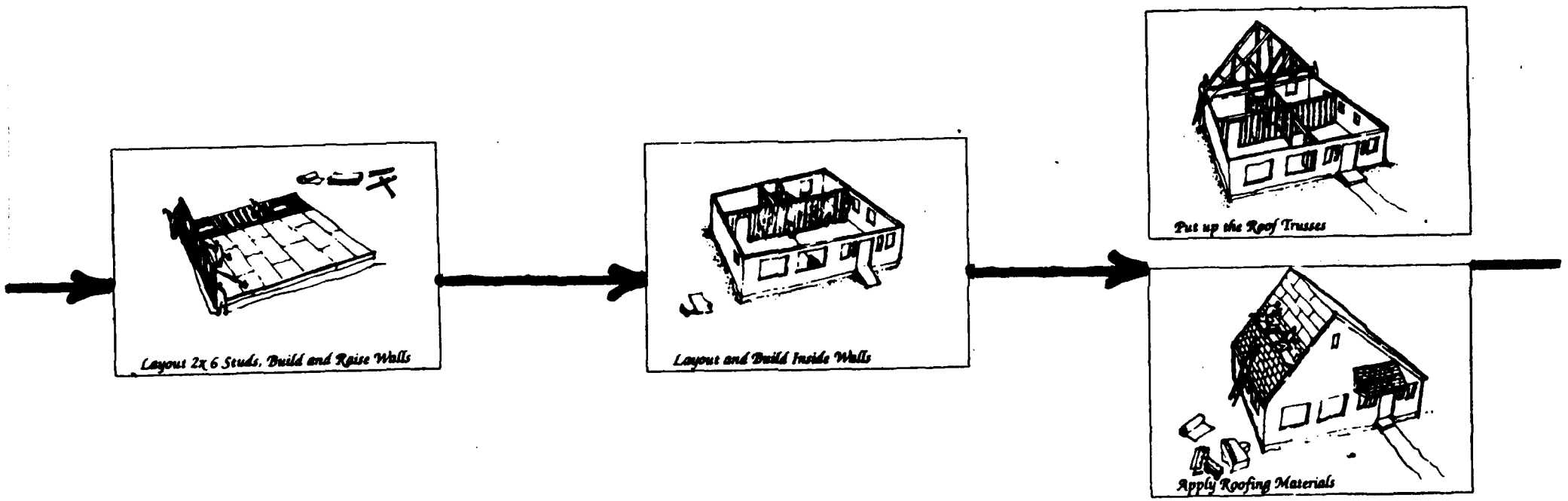


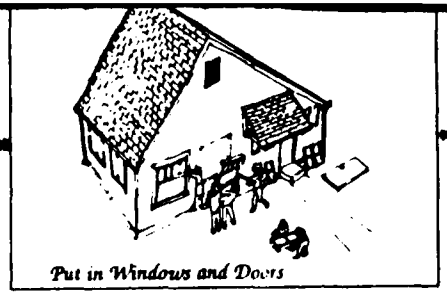
List the Materials



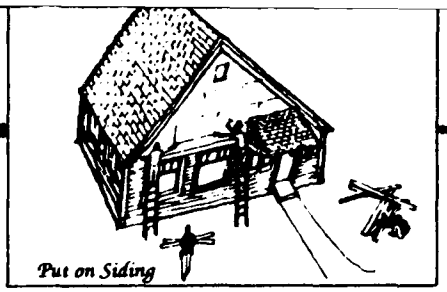
Buy the Materials


Put in Sewer and Water Lines
Build the Foundation
Build the Floor

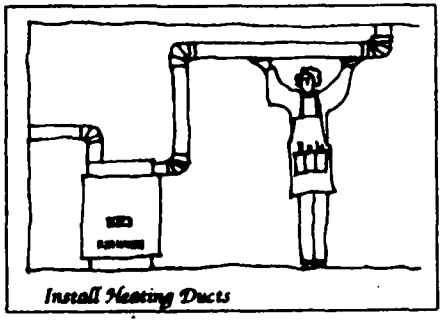

Layout 2x 6 Studs, Build and Raise Walls
Layout and Build Inside Walls
Put up the Roof Trusses
Apply Roofing Materials



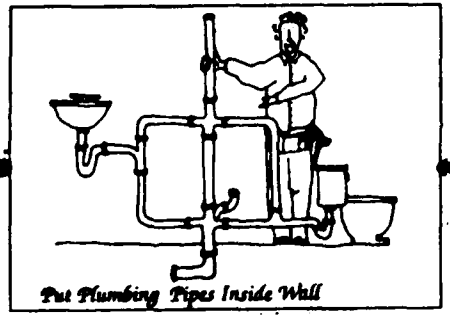
Put in Windows and Doors



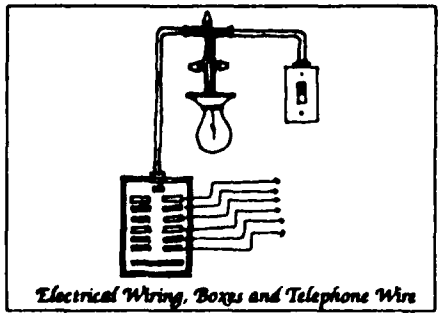
Put on Siding



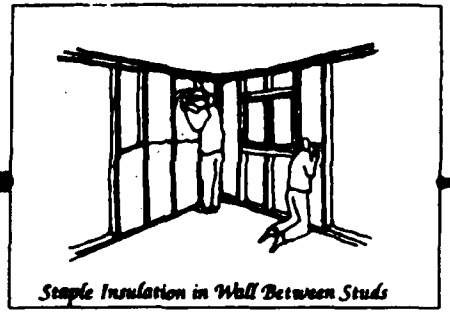
Install Heating Ducts



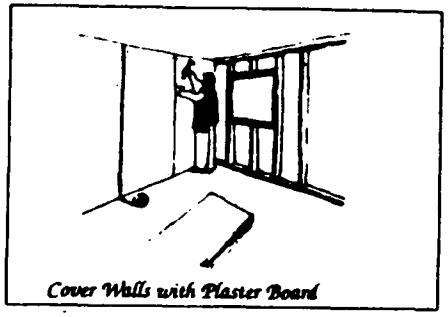
Put Plumbing Pipes Inside Wall



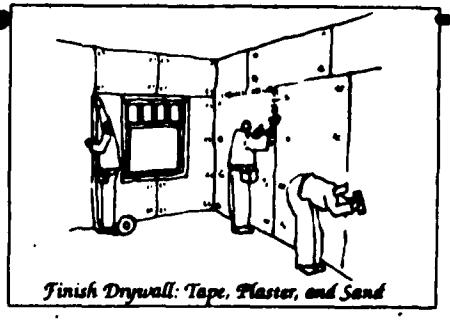
Electrical Wiring, Boxes and Telephone Wire



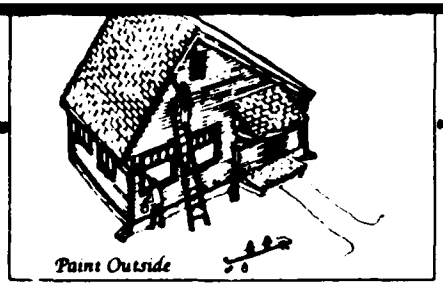
Staple Insulation in Wall Between Studs



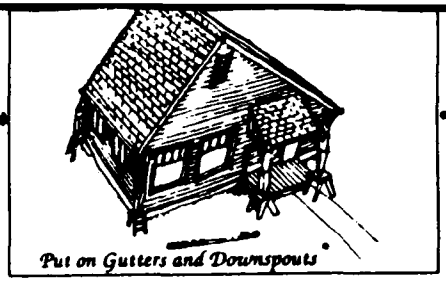
Cover Walls with Plaster Board



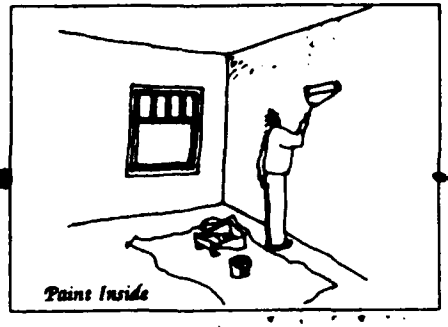
Finish Drywall: Tape, Plaster, and Sand



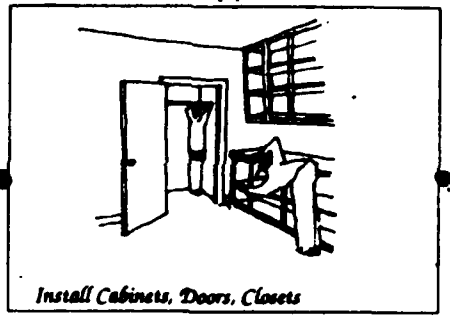
Paint Outside



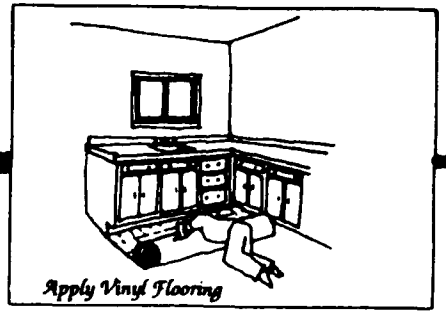
Put on Gutters and Downspouts



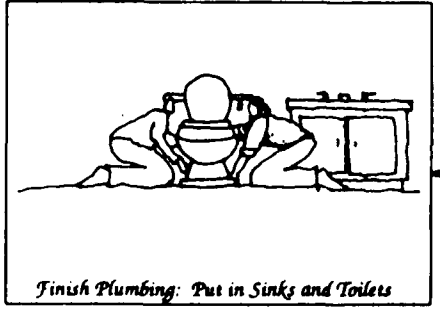
Paint Inside



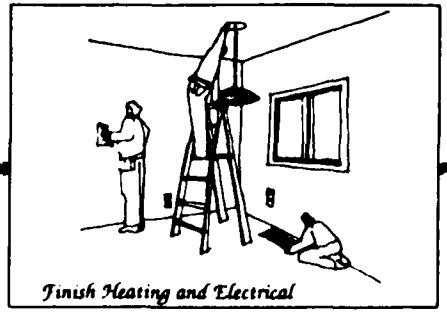
Install Cabinets, Doors, Closets



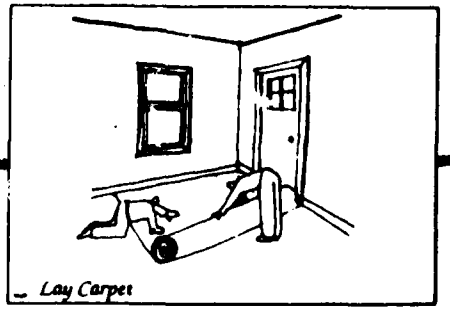
Apply Vinyl Flooring



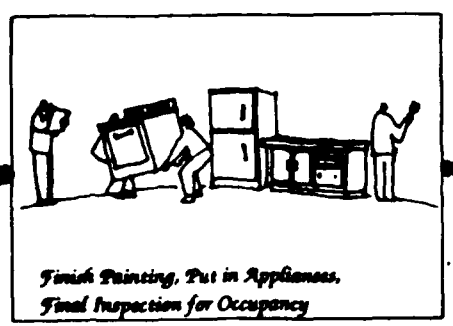
Finish Plumbing: Put in Sinks and Toilets



Finish Heating and Electrical



Lay Carpet



Finish Painting, Put in Appliances, Final Inspection for Occupancy