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Habitat Productivity

RAHUL JOHN YOUNG

Managing Civil Engineering Projects
Civil Engineering 100

Martin A. Fischer, Assistant Professor
Habitat Productivity

Introduction

This paper is a study of the productivity of Habitat for Humanity volunteers, and of the potential and rationale for improving this productivity. It begins by explaining the background of the organization, and proceeds into the extent of the organization's present focus on productivity, and the perceived barriers to increasing this productivity. There will then be a number of case studies, involving direct comparisons of volunteer productivity to professional contractors' productivity. These studies will show that Habitat's productivity, defined as speed of construction, is approximately one-third of professional productivity, while Habitat's cost is a little over one-half of professional cost. Finally, the paper will show that the decreased productivity can be directly linked to the perceived barriers and to the volunteers' lack of skills.

Organizational Background

Habitat for Humanity is an international organization which uses primarily volunteer labor and material either donated or bought using donated money to build housing for the working poor. The organization has enjoyed a recent surge in popularity, partly due to former President Jimmy Carter's long-standing affiliation with Habitat, as well as a Newt Gingrich proposal, tongue-only-slightly-in-cheek, to eliminate the Housing and Urban Development Agency and turn all of HUD's funding over to Habitat projects. The organization has affiliates throughout the country and world. These affiliates receive guidelines and a small amount of
funding from the International organization, but are generally responsible for their own design, fundraising, and construction. Volunteers often appear on Habitat construction sites with no previous building experience or knowledge, and are led and directed by one of the site’s construction managers.

Peninsula Habitat for Humanity, the affiliate at which I worked, and on which this study is based, works in the Bay Area south of San Francisco. This affiliate is currently working on a number of multi-family dwellings in East Palo Alto. These buildings, when finished, will range from a single floor area of 4000-5500 feet and will be 2-3 stories high. Peninsula Habitat has a goal of working with 25 on-site volunteers from Tuesday through Friday, 8:30--4:30, and 40-50 volunteers on Saturdays. The Habitat administration has hired two on-site construction managers to direct the project volunteers, and also employs other skilled workers, depending on the number of volunteers who will be working on site. Though Peninsula Habitat does achieve most of its construction through a combination of their hired managers and volunteer labor, a few tasks, such as plumbing and truss-building are performed by subcontractors, due to their specific complexity or especially small margin for error.

How important is productivity?

On the walls of the Peninsula Habitat volunteer building, one can see the clearly stated list of priorities given by the administration to the site managers. It is as follows:

---Safety

---Quality

---Productivity

Thus, it is clear from the outset that productivity, while important, is a tertiary consideration compared to the well-being of volunteers and the stability, strength,
and workmanship of the building. The Habitat managers set goals for construction completion, and establish a few intermediate general goals. For example, on two of the dwellings presently under construction, there is a goal of having the roofs on by the end of the year, in order to protect the houses' interiors from the winter rains. Beyond this, the Habitat managers do not have a daily construction schedule, nor do they have a daily log in order to record the construction progress. They feel that the number of volunteers present each day is too variable to make either of these practices very worthwhile. Instead, they are content with getting the most work done possible each day, performing some preplanning for the upcoming days and weeks, and proceeding at the rates which the volunteer numbers enable.

At some Habitat affiliates, there is sometimes an effort to suppress productivity. For example, at the Sacramento affiliate, the administration perceives fundraising and land acquisition to be the primary constraints on the growth of the organization. As a result, the affiliate might not have another project ready to start by the completion date of their current project. In order to avoid a gap between projects which could alienate potential volunteers, the site managers often restrain productivity in order to extend the completion date and close the gap between projects.

However, this does not seem to be a problem at Peninsula Habitat. At this affiliate, fundraising outstrips construction, and instead of holding back the completion of a project, the administration instead is able to focus on acquiring the land, and coordinating the funds for the new project to piggyback off of their current work.

There are a number of factors which seem to make an increase in productivity important:

---Every month in delay costs $25,000 in overhead.
Many of the families who are working to earn a Habitat house face marginal living conditions and possible displacement until their house is completed.

Volunteer satisfaction rises and attrition drops as productivity increases. I have only anecdotal evidence of this assertion. After speaking with a number of volunteers at the end of a workday, I have been witness to a wide range of emotion and satisfaction, which appears to be directly tied to what was accomplished on site that day. Even without *Means Building Construction Cost Data*, volunteers seem to have a good general idea of how productive they and their team have been. On days or tasks which have been bogged down in miscommunication or low productivity, some volunteers have openly voiced their dissatisfaction with the work and question whether they should return to site. Naturally, when people make the attempt to give of themselves, they want to know that they've accomplished something.

Given these motivations for increasing productivity, what stands in the way at Peninsula Habitat?

**Barriers to increased productivity**

The Habitat on-site construction managers, along with Boyd Paulson, a Stanford University Civil Engineering professor who has established a close relationship with Peninsula Habitat, gave me a list of factors which they consider to be barriers to increased volunteer productivity. They are as follows:

---Low weekday volunteer turnout.
---Lack of preplanning by managers.
---Lack of communication between workgroups.
---Complexity and large scope of building design.

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1 All quotes and citations are taken from an e-mail from Prof. Paulson, received on Nov. 21, 1996
There is no stated solution or approach to the last two problems, but the Habitat administration has taken steps to remedy the first two. Low volunteer turnout is very seasonal, and increases when local colleges and high schools are in session. In the last few months, Peninsula Habitat has hired an Americorps Vista volunteer to increase outreach to local colleges and businesses, and has seen marked increases in the number of volunteers as a direct result of this effort. The administration feels that it has little control over last-minute cancellations and no-shows, but it is in the process of creating a web page and e-mail list to quicken the means of communication and provide a simple method of directly contacting potential volunteers. Peninsula Habitat has goals of 25 volunteers on weekdays, and 40 on weekends when there are more skilled workers and supervisors. The e-mail list and outreach is directed toward meeting these goals.

As for the preplanning, Peninsula Habitat has recently solicited help from Stanford Civil Engineering graduate students in laying out the plans for future tasks. These students have prepared preplans for roofing, windows, electrical systems, and framing. According to Prof. Paulson, these efforts have already proved to be helpful in the case of sheetrocking, as student plans have been implemented with minor modification. This saves time and effort for the Habitat managers. In addition, Prof. Paulson, believes that other preplans have the potential to increase productivity, after being refined by the Habitat project managers. The extent to which the Stanford graduate students have actually increased productivity on-site is a topic which I will attempt to address in the case studies.

No direct action has been taken to ameliorate the communication problems between workgroups. The Habitat managers are making increased efforts to supervise the different phases of particular tasks in order to provide some level of continuity between disparate groups working on similar parts of a project.

The managers feel that any more formalized means of communicating, such as a
written list of each workgroup's task and approach, would be overly time-consuming and relatively ineffective. Generally, they feel that the ebb and flow of different volunteers makes a certain lack of communication inevitable.

The complexity of the design is a direct function of the scope of the project. Though Habitat for Humanity generally focuses on single-family dwellings, Peninsula Habitat has extended the scope to multi-family dwellings. As Prof. Paulson states, this direction is both landmark and necessary:

Few if any of 1200 other affiliates have tried anything like this. Success here is important, because land on the Peninsula is getting too expensive to find many more lots for single-family homes affordable to our families' income levels.

The drawback of the multi-family house approach is the increase in the number of different tasks occurring at the same time, virtually all of which require some level of supervision from the on-site supervisors. Adapting Habitat's volunteer methodology to this new range of tasks remains a barrier to increased productivity, but is something which the Habitat managers believe will improve with added time and experience. An adaptation of design is another possibility, in an effort to make it more volunteer-friendly. However, it was the opinion of the site managers that any design of a multi-family-size house that was to be built in Peninsula Habitat's time guidelines would have similar volunteer coordination problems. According to them, a decrease in the number and complexity of tasks could only be achieved through a decrease in the size of the project or an increase in the time required to build it. Neither is a sacrifice which Peninsula Habitat is willing to make.

One area which the Habitat managers surprisingly do not consider to be a hindrance to productivity is the inexperience of volunteers. As Prof. Paulson says:
The lack of skills of the volunteers who do come is not really as big of a factor— their motivation and quick learning ability more than compensates for this. With good preplanning and direction, we have proven that unskilled volunteers can tackle complex tasks and do them at quality levels above what is typical in the residential building market.

The Habitat site managers agree that the lack of skills among many volunteers is not an insurmountable problem, but they are not quite as optimistic as Prof. Paulson. They all cited examples in which project tasks had been set back hours or days due to a planning or construction error by a volunteer. I personally experienced this potential shortfall in productivity as well. After spending an afternoon framing a wall laid out by Stanford CE graduate students, I found out the following week that the wall had been laid out 3 feet short, and thus a later crew had to demolish it and rebuild it. This is not a very satisfying feeling, but would seem to be somewhat inevitable until volunteers climb up the learning curves of on-site construction.

Prof. Paulson, citing some CE 240 students’ projects, believes that the Gloria Way Habitat project is actually progressing at a faster rate than some professional projects. The site managers, again, are not so optimistic, but they believe that the project’s productivity is relatively good, given their constraints on labor and supervision. I will now turn to my productivity comparison data in order to add another opinion to the debate.

Case Studies

The following is a direct comparison of the time and costs of Habitat volunteer performance to the work of professional contractors. I took all of the Habitat data directly from observations from my time on site. All of the professional data comes from Means Building Construction Cost Data, 1995 ed. All Masterformat codes are listed next to their corresponding professional figures.
I make the following assumptions:

--- Material costs for Habitat and professional projects are the same. Thus, all cost discrepancies come from the difference in labor costs.

--- The San Francisco City Cost Index of 127 is most applicable to the project. All costs will thus be multiplied by a factor of 1.27.

In addition, all figures will be calculated to correspond to the units listed in *Means Building*. A thousand board-feet (MBF) is equivalent to 183 cubic feet. Or, 5.5 board-feet equals one cubic foot.

Because this is a study of average Habitat productivity, I will mention any factors which may have unexpectedly increased or decreased productivity from its average.

Cost and productivity comparisons are represented by the Habitat figures as a percentage of the professional figures. Thus, figures greater than 100% would represent higher Habitat productivity and cost than the corresponding professional data.

Final averages for cost and productivity comparisons are calculated by simply averaging the comparisons for each task.

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**Friday, Oct. 4—Blocking**

Task: Cut and install wood blocks between beams of first-floor ceiling.

Team: Two people cutting blocks for two hours, and nailing blocks for two hours. Six people nailing blocks for four hours. This equals a total of 32 person-hours.

Accomplishment: Cut and nailed 80 12-inch by 4-inch blocks, a total of 146.7 board-feet (BF).
<table>
<thead>
<tr>
<th>Blocking</th>
<th>BF/32 person-hours</th>
<th>Cost/MBF</th>
</tr>
</thead>
<tbody>
<tr>
<td>061-102-2520</td>
<td>146.7</td>
<td>$821</td>
</tr>
<tr>
<td>Professional</td>
<td>680</td>
<td>$2,282</td>
</tr>
</tbody>
</table>

| Productivity Comparison | 22% | 36% |

Mitigating Factors: None.

Friday, Oct. 18--Wall1

Task: Build and sheath an interior bedroom wall.

Team: Six people, cutting, laying out, nailing, sheathing, and erecting the wall for 4 hours. This equals a total of 24 person-hours.

Accomplishment: Completed one 8-foot by 9-foot wall, a total of 396 board-feet.

<table>
<thead>
<tr>
<th>Wall1</th>
<th>BF/24 person-hours</th>
<th>Cost/MBF</th>
</tr>
</thead>
<tbody>
<tr>
<td>061-128-6020</td>
<td>396</td>
<td>$795</td>
</tr>
<tr>
<td>Professional</td>
<td>795</td>
<td>$1,741</td>
</tr>
</tbody>
</table>

| Productivity Comparison | 50% | 46% |

Friday, Oct. 25--Wall2

Task: Build and sheath an interior bedroom wall.

Team: Eight people cutting, laying out, nailing, sheathing, and erecting the wall for 4 hours. This equals a total of 32 person-hours.

Accomplishment: Completed one 8-foot by 9-foot wall, a total of 396 board-feet.
<table>
<thead>
<tr>
<th>Wall2</th>
<th>BF/32</th>
<th>person-hours</th>
<th>Cost/MBF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Habitat</td>
<td>396</td>
<td>$795</td>
</tr>
<tr>
<td>061-128-6020</td>
<td>Professional</td>
<td>1060</td>
<td>$1,741</td>
</tr>
<tr>
<td>Productivity Comparison</td>
<td>37%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost Comparison</td>
<td></td>
<td></td>
<td>46%</td>
</tr>
</tbody>
</table>

Mitigating Factor for Wall Task:

---The layout time, which was incorporated into the time calculation, was part of an experiment with Stanford CE Grad students who had little to no previous experience with the activity. Thus, in the process of learning the most efficient layout process, productivity was likely lower than average.

Friday, Nov. 8--Trusses1

Task: Install trusses on roof across bedroom unit.

Team: 3 people, working for 4 hours, a total of 12 person-hours.

Accomplishment: Moved and installed 8 22-foot trusses covering an area of 400 square feet.

<table>
<thead>
<tr>
<th>Trusses1</th>
<th>sq. ft./12</th>
<th>person-hours</th>
<th>Cost/sq.ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Habitat</td>
<td>400</td>
<td>$1.84</td>
</tr>
<tr>
<td>061-908-0210</td>
<td>Professional</td>
<td>1500</td>
<td>$2.26</td>
</tr>
<tr>
<td>Productivity Comparison</td>
<td>26%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost Comparison</td>
<td></td>
<td></td>
<td>81%</td>
</tr>
</tbody>
</table>

Friday, Nov. 15--Trusses2

Task: Install trusses on roof across bedroom unit.

Team: 5 people, working for 3 hours, a total of 15 person-hours

Accomplishment: Moved and installed 12 25-foot trusses, covering an area of 484 square feet.
<table>
<thead>
<tr>
<th>Trusses2</th>
<th>sq. ft./15 person-hours</th>
<th>Cost/sq.ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>061-908-0210</td>
<td>484</td>
<td>$1.84</td>
</tr>
<tr>
<td>061-908-0210</td>
<td>1875</td>
<td>$2.26</td>
</tr>
<tr>
<td>Productivity Comparison</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>Cost Comparison</td>
<td>81%</td>
<td></td>
</tr>
</tbody>
</table>

Mitigating Factors for Trusses Task:

---The team consisted of two of the most skilled workers on-site, one of whom was a construction manager. This could cause the productivity to be higher than the average.

---The professional construction data incorporates the use of hydraulic equipment and a crane, both of which were not used in the Habitat work. This could potentially skew the data in favor of professional productivity.

Friday, Nov. 23--Roof Strongbacks

Task: Install 2X4 strongbacks across trusses of roof.

Team: One person, working for 4 hours, a total of 4 person-hours.

Accomplishment: Installed 88 board-feet of strongbacks.

<table>
<thead>
<tr>
<th>Strongbacks</th>
<th>BF/4 person-hours</th>
<th>Cost/MBF</th>
</tr>
</thead>
<tbody>
<tr>
<td>061-120-7880</td>
<td>88</td>
<td>$753.75</td>
</tr>
<tr>
<td>061-120-7880</td>
<td>125</td>
<td>$1,750.70</td>
</tr>
<tr>
<td>Productivity Comparison</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Cost Comparison</td>
<td>43%</td>
<td></td>
</tr>
</tbody>
</table>

Mitigating Factors:

---There had been rain throughout the morning. The resulting wetness and soakage caused electrical problems throughout the afternoon, and hence slowed the use of power tools necessary to the task.
---The professional data did not have a category for strongbacks. The closest alternative which I could find was a 2X6 ridgeboard figure.

Conclusions:

<table>
<thead>
<tr>
<th>Average for All Tasks</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Productivity Comp.</td>
<td>39%</td>
</tr>
<tr>
<td>Cost Comp.</td>
<td>56%</td>
</tr>
</tbody>
</table>

Due to the small sample size, it would be dangerous to draw many broad conclusions from this data. However, this much is clear: despite previous assertions by some of the Habitat management to the contrary, Habitat productivity does seem to be low compared to professional construction, very significantly in some places. The cost of construction is similarly low--almost half of professional costs. It is important to consider that, according to the site managers, Peninsula Habitat has had an exemplary safety record and the quality of its houses have approached a "custom-design" level.

Nevertheless, a shortfall between Habitat volunteer and contracting professional productivity exists. In certain cases, it is possible to see the connection between this shortfall and the previously stated barriers to productivity. The Blocking task suffered from the lack of an experienced manager to supervise the volunteers. I attribute this to the complexity of the building design, which necessitated the parallel completion of other tasks, pulling the managers away from blocking, in this case. The trusses task, though undertaken by a very skilled team, occurred at only one-quarter of the speed of a professional contractor. This may be due to a lack of preplanning by the managers, as they spent a significant amount of the work time discussing the proper spacing and layout of the trusses. Low volunteer turnout is
significant, though only in the strongback case, for that is the one case in which the Habitat team was smaller than the suggested professional team (one person instead of two). Lack of communication does not seem to be directly related to the productivity shortfall, though as mentioned before, it became significant when Wall1 from the case studies was later demolished because it was built to the incorrect dimensions. Finally, it seems that the volunteers’ lack of skills was indeed a barrier to productivity. In the case of both Wall1 and Wall2, Stanford Civil Engineering graduate students, who I think would have more skills than the average volunteer, substantially increased construction time in the process of learning the techniques of layout. Thus, all four stated barriers to productivity, along with the one claimed not to be a barrier, proved to be significant in decreasing productivity.

Peninsula Habitat is taking steps to improve its construction time. The administration seems to understand the barriers to construction and is willing to adapt and expand in order to overcome their limitations. Even if the Habitat managers were to agree with the conclusions of this paper, and change their outlook on the impact of volunteers’ lack of skills, I question how much they could do to change the situation. Volunteers are the backbone of the organization, and the inclusiveness of Habitat to people from all walks of life, regardless of construction skill, is the value which defines Habitat’s mission. Ideally, every volunteer who walked on site would return on a weekly basis and gain the necessary knowledge to become more skilled. However, this is not realistic, and is clearly not necessary for Habitat to become a viable, efficient organization. Peninsula Habitat for Humanity is far from perfect, but it accomplishes its goals, maintains a clear and necessary list of priorities, and is taking steps to improve. Habitat will never become a professional contracting firm, but I know few people that would ever wish it to do so.