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A Systems Approach to Residential Construction – Development of a Production Manual

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To remain competitive, residential builders must improve their organizations and systems to handle production more efficiently. The National Association of Home Builders (NAHB) Production Builders Committee realized the need for standardizing construction procedures among residential construction companies and commissioned the authors of this article to write a Production Manual for residential builders. In essence the manual addresses each phase of construction and outlines the construction standards that apply to each. The objective was to create, assemble, and edit a comprehensive manual of production standards which could be published in a loose-leaf format and be made available to individual builders on computer disks. This would allow builders to easily modify and customize these standards to meet their own requirements. Taking a systematized approach to the construction process has reaped abundant rewards for some builders and has generated some not-so-obvious advantages. As expected, systems became more efficient and better organized, and owners benefited because of more uniform production within their own companies. Some of the unexpected benefits resulting from the process of standardizing production procedures were greatly improved communication and understanding between employees within each of the companies. Also, the introspective self-evaluation function that each company went through helped the leadership to better define each company's mission and helped everyone in the organizations to more clearly focus on company goals. Other benefits were also recognized.

Key Words: Production Standards, Residential Construction Management, Communication, Production Manual

Introduction

Most residential builders start out as small volume builders and increase their volume of production as the market and company capabilities permit (Dasso, 1988; Music, 1985; and Schleifer, 1990). Due to improvements in management proficiency, builders are finding they cannot do business as usual and remain competitive. There is an increasing demand to improve performance in the face of increased competition (Brown, 1983; Donohue, 1995). As builders try to remain competitive, and especially as their volume increases, companies are being forced to improve their organizations and systems to handle production in a more efficient way.

Builders are feeling the need for greater standardization within their companies. Initializing a systematized approach to the construction process has reaped abundant rewards for some builders and has generated some not-so-obvious benefits.

Perceiving a need for standardizing their production and operation procedures, individual industry leaders in residential construction, have developed production and operational manuals to be written for their individual companies. The National Association of Home Builders (NAHB) Production Builders Committee realized the need for standardizing construction procedures among residential construction companies and commissioned the authors of this article to write a Production Manual for residential builders. In essence the manual addresses each phase of construction or activity performed and outlines the construction standards that apply to each. The objective was to create, assemble, and edit a comprehensive manual of production standards which could be published in a loose-leaf format and be made available to individual builders on computer disks. This would allow builders to easily modify and customize these standards to meet their own requirements. It would also result in great savings to builders who use the manual as some builders have spent over $30,000 to produce their own production and operation standards.

A customized version of the Production Manual was previously implemented by three companies. The three companies range in production from 450 to 850 homes per year. The results impressively validated the effectiveness of production standardization. The authors solicited input from builders from widely diverse geographic regions. Most of the builders had written their own production standards and were willing to allow the authors to incorporate portions of their standards in the Production Manual. The individual activities were divided into phases of construction according to the following chapters:

1. Excavation, Footing, Foundation through Backfill
2. Framing
3. Rough Mechanical
4. Exterior Finish
5. Interior Finish
6. Completion

An overview of each production activity was presented, and the procedures for completing each activity were outlined (Appendix A). Special attention was given to make sure that, as much as possible, construction methods representing the construction practices and various regions of the country were included. For example, builders in some areas of the country build basements while others build crawl spaces and still others use slab-on-grade techniques. All three methods were included in the manual. Some unique systems were deemed to be micro-geographic differences, such as the use of caissons for expansive soil in residential building in the Denver, Colorado region, and were intentionally left out. Special attention was given to safety concerns. In addition, chronic problems of clean up, compliance with building codes, and other issues were addressed for each trade.

In order to facilitate the implementation of the standards, quality control checklists (Appendix B) were also developed for each of the major trades to be used by superintendents and subcontractors to inspect completed work.

In addition to a text version of the production standards, line drawing graphic representations were also included to enhance the descriptions. Line drawings were included so that they could

be easily reproduced by builders in their customized production manuals. Draft copies of the Production Manual were distributed to a review committee consisting of seven builders from throughout the U.S. They reviewed the manuscript and submitted suggestions on improvements. The final manuscript was then submitted to the NAHB for its approval.

Benefits Of Standardization

In studies done over the last five years, some interesting concepts have surfaced. Prior to the process of standardizing construction procedures for production and operations began, some of the benefits such as smoother, less confusing paper flows, and cleaner and more efficient methods of operation were expected. What were not anticipated, however, were the many other benefits resulting from the effort. Following is a summary of the major benefits gained through the process of standardizing the procedures for production and operations for various residential companies throughout the United States.

Self-Evaluation

The standardization process began with a thorough self-evaluation of all elements of the construction company. Each employee and many suppliers and subcontractors were interviewed. Employees discussed their own perceptions of the company, what practices worked and which ones should be changed. They described their roles in the company and how employees could more effectively contribute to the company. Companies discovered a lot about themselves. It was surprising to learn how little owners, presidents, and managers sometimes knew about the inner workings of their companies.

Enhanced Job Descriptions

Most employees are hired to do specific jobs. Over time, and as responsibilities and employee capabilities change, employees sometimes are not sure where their duties and responsibilities start and where they end. One benefit of the standardization process was that it helped to define the roles and responsibilities of employees within the company. Part of the outcome established current and more accurate job descriptions for all employees. The formal organizational structure was sometimes modified as a result of the findings. Sometimes, employee responsibilities were modified or restructured so that employees could focus on areas of greater need within the companies.

Improved Communication Within Companies

Another benefit came only because of the standardization process. As employees were interviewed individually and in groups, lines of communication were opened and employees gained greater insight into their own responsibilities and how they could better interact with others. The process itself initiated dialog within the company. Often, issues surfaced about problems of which others in the company were unaware. Employees found that many problems could be solved simply by discussing them with their co-workers.

Create Focus on Company Goals

As problems and solutions were considered in discussion groups, employees and employers began to gain a sense of where their companies were going. This inward evaluation process created a focus on real company goals and direction. Employers were more easily able to articulate their company's mission. Employees gained greater understanding of the direction and goals of the companies and began to take more ownership in their company's success.

Systems Organization and Efficiency

A major benefit of the standardization process was that company policies and procedures were thoroughly analyzed. Confusing or misunderstood practices such as how to handle Variance Purchase Orders or Measurement Purchase Orders were clarified. Procedures and policies were streamlined, making whole systems more efficient and effective.

Employee and Subcontractor Training

In companies where standardized practices and procedures are not written down, employees require more time to learn their roles, responsibilities, and privileges. Using company operation and production manuals helped employees and subcontractors learn their specific responsibilities and procedures more quickly. These manuals can be used for training new personnel and as references for long-time employees. Portions of the manual can also be included as part of subcontracts.

Uniformity throughout the Company

One problem of residential companies is that products don't always meet with customer expectations. Production builders, especially, encounter this difficulty. While selecting a builder, customers will visit various sites. The quality will vary between models and the workmanship will vary between different supervisors. A customer may see a high quality model in one area and buy in a different location. If the home they buy is not to their expected standards based on their previous experience, they will be very disappointed. Standardizing production creates uniformity throughout each company division. This greatly helps to keep customer expectations uniform for all production locations and helps subcontractors who work for more than one division.

Conclusion

Builders used the Production Manual to train new project supervisors. Although many new supervisors had previous experience in residential construction, they were not familiar with the construction methods and materials that were being used by the company doing the hiring. The Production Manual was used as a training guide for inexperienced supervisors and as a reference for seasoned employees.

Responses from the various participants demonstrated that the Production Manual was an advantageous tool for superintendents to standardize their production methods. One production manager explained that the Production Manual had been very beneficial in training new subcontractors. He gives all new subcontractors copies of the sections of the Production Manual and Quality Checklists which pertain to their particular sub-trades along with written subcontracts when he "sets up the subcontractors" to perform work. He reviews the copied sections of the Production Manual and Quality Checksheets in detail with the subcontractor at that point.

Superintendents used the Production Manual to train subcontractors as they visited the jobs on a daily basis and used the checklists to review and check the work of subcontractors prior to approving payment. One production manager indicated that the use of the Production Manual and Quality Checklists significantly reduced the cost of construction, because employees and subcontractors knew what was expected of each trade, thus, eliminating many mistakes and rework.

Another significant benefit of using the Production Manual was that the companies saw increased uniformity throughout all production lines and company divisions. Customers' expectations were the same across project locations. In each case, the builders that implemented a production manual were impressed with the process of self-improvement and communication that the approach initiated. They knew that the process would be a continual cycle of improvement within the company.

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Appendix A

Floor Framing

Overview:
This activity includes the installation of the rough framing material including sill plates, bearing walls and beams, joists, subfloor, blocking, and other installations necessary to complete the floor structure of the house.

Procedures:
Duration: 1-2 days for average-size home.

To be completed before this activity begins:

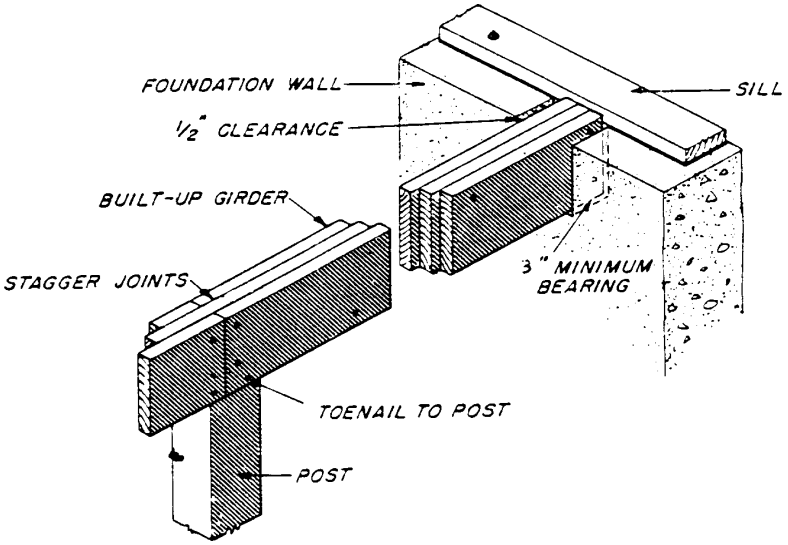
- Backfill complete.
- Temporary electric service available.
- Sewer, water, electric, and gas laterals complete (these could possibly be delayed until framing complete).
- Concrete - basement slab, garage, and front porch complete.
- Rough lumber delivered.
- Roof and floor trusses ordered.
- Doors ordered.
- Windows ordered.

1. The superintendent should meet the framer on the job and review the plans, specifications, and change orders. All changes should be reflected on the customized plans used for the job.
2. All work to be done according to local code regulations.
3. Check foundation for square and adjust sill plates as much as possible if the foundation is out.
4. Use treated plate material for sills resting on concrete or block.
5. Level sill plates starting at the high point of the foundation.
6. Sills should be set in from the outside of the foundation, the thickness of the sheathing except when using brick or stone.
7. Sills for concrete walls should be tightly secured with 1/2" washers and nuts or with anchor straps. 1/2" x 10" j-bolts are to be a maximum of 6' apart and all sill plates anchored within 12"of each end. Missing sill anchors should be replaced with 1/2" wedge anchors or Redheads. Mudsill anchor straps should be placed no more than 3' apart.
8. Sills for masonry walls require 1/2" x 16" j-bolts.
9. Splices in built-up-beams should occur directly over bearing posts. Proper nailing patterns and nail sizes should be used. Refer to the local code.
10. Glue-laminated beams are designed with a top and bottom side. The top has TOP written on it and has square edges. The bottom has rounded edges. The beam is designed with a slight camber which will straighten out when the beam is loaded.
11. Beams and girders should be straight and level to within ±1/8" in 10'.
12. Joist material should be checked for species, grade, and size against the required specification.
13. Joists are to have a minimum bearing of 1-1/2" and are to be installed with the crown up. Layout should be checked so that joists aren't placed under toilet installations.
14. Trimmer and header joists to be doubled when span of the header exceeds 4'.
15. The ends of header joists more than 6' long shall be supported by framing anchors or joist hangers unless bearing on a beam, partition or wall.
16. Tail joists over 12' long must be supported by framing anchors or 2" x 2" ledger strips.
17. Joist framing from opposite sides of a beam, girder, or partition should be lapped at least 3".
18. Solid blocking is required over all bearing points.
19. Subflooring ends should be staggered and all square edges should fall on the center of a joist or be blocked.
20. Subflooring should be glued with construction adhesive and 8d common nails should be spaced 6"O.C. on the edges and 12"O.C. in the field. Ring-shanked (deformed shank) nails or screws can be substituted to reduce floor squeaks.
21. Check nailing patterns for spacing and proper installation.
22. For seismic zones 3 & 4, 2 x 8's are not to be cantilevered without special engineering allowances.

Common Problems and Solutions:

1. Bouncy or spongy floors can be stiffened by using cross bridging at mid-span.
2. Use construction adhesive with subfloor to prevent squeaky floors.

Using Grabber screws instead of nails to secure the subfloor can help prevent squeaky floors.



Built-up Girder Set into Concrete Beam Pocket and Bearing on Wood Post (Feirer, 1993)

Appendix B

Layout and Footing Checklist

Subcontractor _____ **Job Name/No.** _____

_ All work must comply with local, state and the national codes, even in areas where no local inspection exists.

LOCATION/LAYOUT

_ Property lines surveyed by licensed surveyor or certified by the owner.
_ Property survey stakes in place.
_ Plot plan available.
_ Confirm that the layout is per owners agreement at the site meeting.
_ Correct front yard set back. Ft.
_ Parallel to the street to within 1 inch if applicable.
_ Correct side yard set back. Ft. Which side?
_ Rear yard set back. Ft.
_ Check for presence of ground water or soft spots in the soil.
_ Footing below the frost line after backfill is completed if applicable.
_ Check for proper elevation. Should provide for 5% grade away from building after backfill.

FOOTINGS

_ Inspector notified at least 24 hours ahead of time.
_ Inspection completed and inspection card signed.
_ Footings checked for position and proper grade. Double check layout.
_ Dirt thrown to the outside.
_ Soil under footing is undisturbed or compacted and adequate to support structure.
_ Sides of footings are cut square. Forms in place and properly braced.
_ Soil unfrozen, without snow or ice.
_ Check ALL dimensions.
_ The length is correct, all sides, to within +½" (BUT NOT SHORT!)
_ Square ± ¼" in 20'.
_ Diagonal measurements equal ± ½ inch.
_ Check for proper size location and elevation of blockouts.
_ Check offsets and jogs. Location Size.
_ Footing depth in inches 8" ± 1". Width in inches 18" ± 1".
_ Footing steps in 8" increments.
_ Metal rebar grade stakes 5' o.c. and set to grade with a builder's level.
_ Forms level ± ¼ in 10' and level ± ½ " overall.
_ Forms properly braced and backfilled.
_ Footings free of roots and topsoil.
_ Footings free of debris.