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Platts, R. E.

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SHOPS FOR WOOD-FRAME HOUSE PREFABRICATION

By

R. E. Platts

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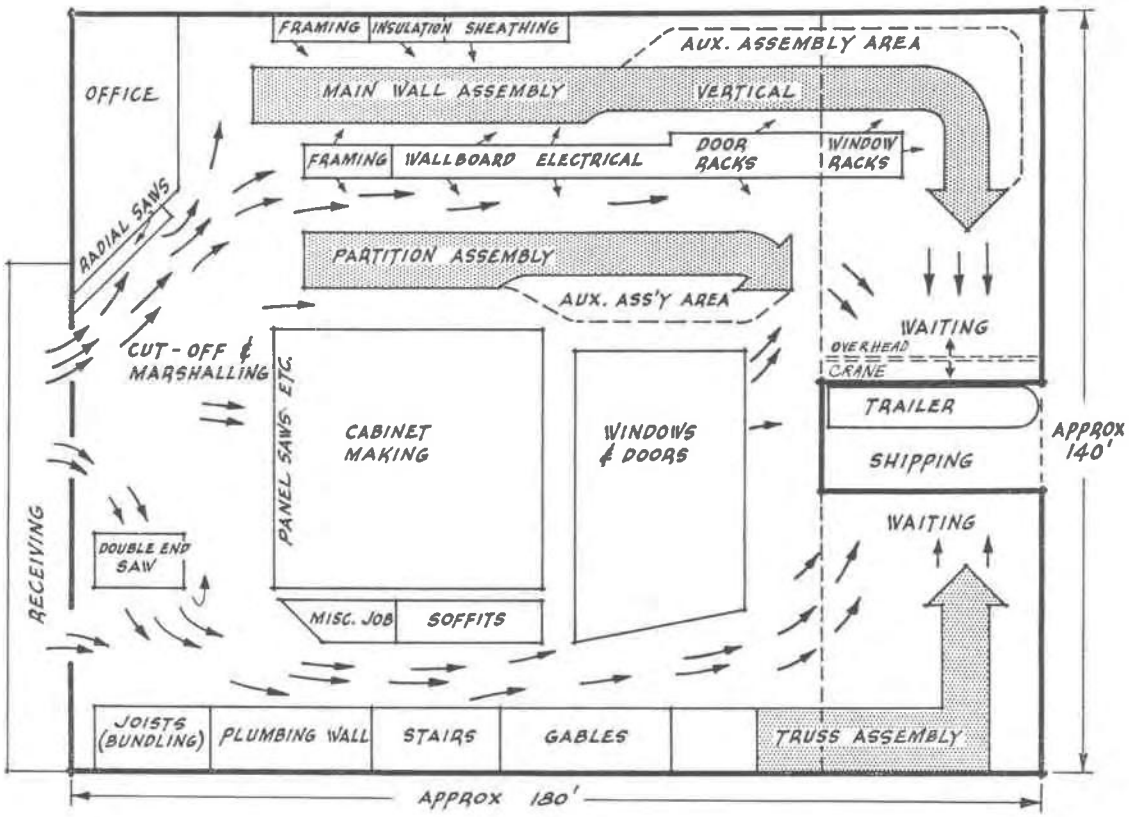


FIGURE 1 A PRELIMINARY LAYOUT: WOOD FRAME HOUSE PLANT
APPROXIMATE CAPACITY: 3 to 5 HOUSES/DAY, SINGLE SHIFT

Shops for wood-frame house prefabrication

The availability and low cost of equipment for prefab shops (compared to factories producing any other "major appliance") may encourage builders and dealers to jump into prefabrication with little hard thinking on the actual role of the shop. The dominant aspect of wood-frame house construction, with its many trades and hundreds of varying pieces, is materials handling. This is the aspect that a simple, well-planned shop can improve most radically, both for shop and subsequent field operations, as was emphasized in the first note in this series. Setting up a small shed or two and a bit of yard as a prefab "plant" does not readily allow rationalized handling and logistics, and the operation may gain little or nothing.

An industrial engineering study of wood-frame prefabrication is badly needed, but apparently none has yet been attempted. The publication "Prefabrication in Canadian Housing", (NRC 7856) attempts to draw conclusions from the many impressions gained on diverse shop practice in the survey across Canada. It also presents some discussion on production aspects of stressed skin, structural sandwich, and certain other innovations in house building. This note considers these impressions only as they affect builders' needs at present, dealing with wood-frame construction alone.

LAYOUT

The term "factory" always suggests a picture of a smooth "flow-line" or "assembly-line" layout, and indeed much of our economy is based upon the productivity attained by flow-line production of repetitive units. With wood-frame house production, the number and diversity of parts and the fluctuation in sizes, styles, and production volume make it very difficult to maintain a workable balance if a true flow-line layout is used. One product will "pile up" on the next; one process will fall behind the others. It should be best to use "layout by process" for most measuring, cutting, and marshalling, and to lead this into flow-line layout for handling and assembly. **Figure 1** shows a hypothetical plant layout incorporating these and the following suggested points.

Materials handling is all-important, but wood-frame production does not lend itself to complex, fixed handling equipment. It involves intermittent moves, many paths and cross-paths, and bulky materials with some feasibility of unit loads. Simple hand trucks fit these requirements best of all. Hand trucks do require large quarters and storage areas, but the prefab shop must be spacious and well laid out to allow high productivity.

Lift trucks can best serve the out-

side storage areas and sheds, but they need not work within the assembly plant itself, except to serve the cutting and marshalling area near the receiving end. Most of the hand trucks should be fitted with appropriate racks so that they can be loaded with the prepared and cut materials within the marshalling area, and then can be moved to the assembly area where the hand trucks themselves become the storage racks at the lines. Transfers are sharply minimized in this way.

Figure 1 suggests that a transverse run of a light overhead crane (less than 10-ton capacity, and of about 40-ft. span) can allow its use for all loading of large parts and for transferring heavy items such as windows from sub-assembly to wall assembly lines.

ASSEMBLY JIGS

The assembly jig is the core of wood-frame prefabrication. The marks of a good jig and its "feeder" racks are simple: the man at the table should rarely have to look for pieces or parts, alter them, look at drawings, use a tape or hold pieces in place. All parts should have a place at hand in suitable racks (the racks can best be on the hand trucks, avoiding transfers). The racks should be marked with the marking keyed to the foreman's working plans and to the "cut-off" sheets. The marking should include the number of parts per house to facilitate the orderly refill of racks. These simple points are important parts of optimum production in wood frame—as important as the part that can be played by high cost mechanization.

Although some use quite complex jig tables with hydraulic "popout" equipment, it appears that the very simple open jig tables work as well as any. These use guides or rails along the edges only, the guides set slightly wider apart than the width of the wall or partition section, with the flat table between them. Wooden wedges or other stops are readily driven into the gap to secure the plates against the studs for nailing, sheathing, etc. "Jig sticks" can be laid along the edge guides to allow the fast location of framing and openings for any model of house. These are long wooden sticks or tapes which are made in sets for a particular house model.

Complicated and expensive "flop-over" rigs are sometimes installed to turn the wall or partition sections over, allowing them to be completed on both sides while on the flat. A sequence evolved by some mobile home manufacturers and house prefabricators avoids such a rig and is at least equally effective. The frame is assembled, insulation pushed in place, and sheathing applied on top, in the first few stations on the flat. This requires the use of friction-fit insulation batts and a separate vapour barrier applied later, which are recommended for Canadian conditions in any case. Then the panels are hoisted to a vertical position and moved along to subsequent stations where wiring, wallboard, windows, doors, and trim are set in, and siding may be applied **(Figure 2).**

Overhead monorail conveyors are often considered for this purpose but they involve a considerable investment in multiple rails, sidings, and switch gear, since it is almost impossible to achieve balance in house prefabrication on a single line. Much lower costs and greater flexibility in scheduling and in the use of space can be gained by using small dollies to handle the panels on edge. Two men can readily handle the panels in this way, and vertical stations can then be set side by side. Lag screws set into the top plates of the panels allow loading on transport trailers by overhead cranes within the shop, and allow optimum unloading and handling on the site by truck-mounted boom cranes.

EQUIPMENT

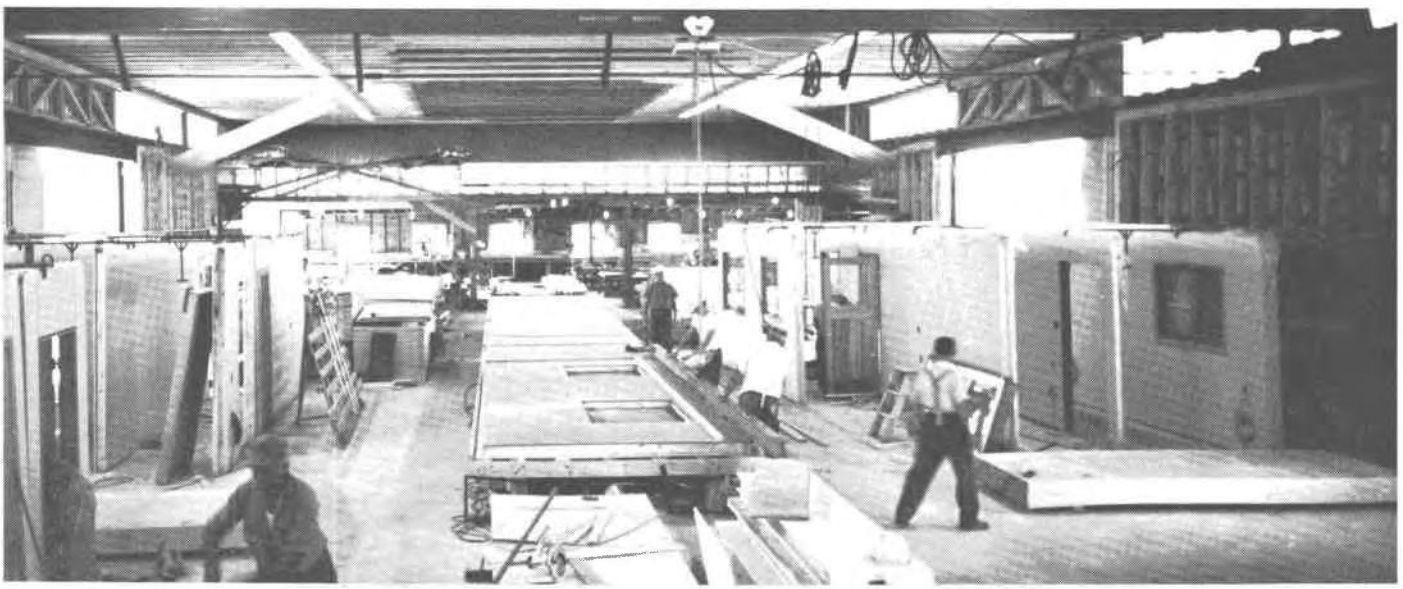
It is difficult to envisage complete mechanization of wood-frame house production. The variability of the lumber, the number of pieces involved, and the low labour content of any one operation all work against high mechanization and automation. The gains achievable through proper organization of materials handling can scarcely be equalled by the adoption of high cost mechanical tools. A few of the larger machinery manufacturers are now concentrating on the wood-frame production field, with intriguing results, but the marginal nature of the mechanization question confirms the wisdom of many house manufacturers who lease all major equipment, rather than buying it at the outset.

Precise precutting is the most important process in wood-frame prefabrication. Most Canadian plants use an in-line arrangement of radial arm cutoff saws for this function. A recent time and motion study confirms this observer's general impression that the process is quite inefficient, due to the end-to-end handling that is involved. The radial saws are invaluable for job-cutting, but using them for standard, high-volume pieces such as common studs can create the worst and most wasteful bottle-neck in the shop. In some areas it is now advantageous to buy precut framing for common studs and other repetitive pieces.

Volumes of four houses and over per day for much of the year may justify the trial leasing of a double-end saw. The saw may cost from $8,000 to $20,000 but it can precut all members for a house in a few hours. Outside sales of precut common studs are desirable to use to the maximum the high production capacity of these saws. Setting up may take considerable time, so long production runs of any one piece are desirable. For this reason the saw should have good storage and marshalling areas around it.

Some pieces of equipment are basic to any shop, large or small. A panel saw is well justified for all sheet cutting. A selfguiding router, or at least a sabre saw mounted in a cradle, will be necessary for quickly cutting out window and door openings after the sheathing has been placed over the frame. And no one doubts the advantages of power staplers for securing all sheathing. Many are interested in the fast-improving pressure-sensitive adhesives for applying wallboard. but any adhesive appears difficult to apply rapidly on narrow frames with uniform results. Few yet use such adhesives, but many have adopted a proprietary power-screw method to apply drywall to reduce popping.

Roof trusses have greatly profited from advances in engineering criteria, fastening devices, and mechanization.



A small shop showing horizontal and vertical assembly stations (Rothwell-Perrin, Portland, Ont.)

Their costs have been sharply reduced and they are commonly used by prefabricators and others. The common method of fixing plates from both sides at two separate stations and then sliding the whole assembly through rollers suffers from the time consumed and from the space required. Other methods use a massive "beam press", or hydraulic "C" clamps to fix all the joints at one station, requiring much less time and space.

Nailing machines are still controversial items, especially the self-feeding types. Those that use common framing nails are subject to jamming, while those using special nails have less jamming trouble but the nails are costly. Pneumatic hammers are favoured by many. They are slow and must be "fed" one nail at a time, but they relieve fatigue.

The decision to incorporate a cabinet shop in the prefab operation will largely depend on the possibility of outside sales. Considerable space is required **(Figure 1)** and the types of wood, production methods, and equipment are somewhat different than in house shell prefabrication. On the other hand, production of cabinetry allows profit to be taken on some of the highest cost items in the house package. This, of course, applies equally well to windows, doors, "built-ins", and all mill work.

INNOVATIONS

In contrast to wood-frame construction, the promising innovations in housing technology have in common an amenability to highly mechanized processes of production. The leading new systems are characterized by fewer pieces to be handled and assembled, fewer materials and processes, more controllable materials and processes, and a higher continuity of process, all favouring optimum machine production. Composite materials of structural sandwich form show great potential over the long range. Developments in bonded wood fibre materials may lead to complete floor, wall, partition, and roof components that satisfy all requirements at sharply competitive costs. Polyurethane cores may allow continuous belt production of sandwich enclosure components that can be thermally and structurally sound with a thickness of only one inch. But wood-frame construction continues to provide technical adequacy at low costs, and still remains a remarkably difficult yardstick against which proposed innovations must be measured. It will be very difficult to replace for the bulk of house structures.