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# Mobile flexible automatized producing line for manufacturing of elements of prefabricated wooden houses

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**ABSTRACT**

In the given article the principles of construction, optimization and automation of building manufactures and the scheme of construction of a mobile flexible automatic industrial line for release of elements of modular wooden houses are examined. The initial analysis of economic efficiency and competitiveness of the automatic transfer line is carried out. The scheme of the organization of construction of panel wooden houses is offered when line is used outside of settlement.

***Keywords*** **-** Mobile flexibl line, automatized producing, wooden houses

## 1. INTRODUCTION

Nowadays in Russia there is an acute problem of supplying the population with accessible individual dwelling of high quality. The potential traditional for the building Russian industry, based on application of brick and concrete is not enough for the fast increase in volume of housing construction. In such situation the technology of industrial production of fast erected wooden frame-panel houses can be very helpful. The industry of construction of such houses in Russia is young enough. Recently in Russia such kind of housing construction had poor reputation of cheap dwelling of poor quality for temporary residence, simply speaking, «barracks». At present, owing to modern technologies, it is possible to create wooden house of the same quality as houses made of heavy building materials.

## 2. FEATURES OF CONSTRUCTION OF THE MOBILE FLEXIBLE TRANSFER LINE

Projecting of mobile flexible transfer line is a complex task, while solving that task it is necessary to consider not only features of construction of robotic modules but also characteristic features of the timber processing and concepts of modern panel housing construction. The mobile platform on which the process equipment will be carried should provide mobility of such line. It is possible to choose twelve meter trailers as such platform the moving of which is possible by means of caterpillar cross-country vehicles or tractors. Taking into consideration the dimensions of a platform, the maximal length of the modular panel is equal 12000 mm., width of the panel is 3200 mm.

While projecting the mobile equipment it is always necessary to consider limitation of a working area and try to minimize the quantity of mobile platforms. A fundamental difference in the process of projecting the mobile equipment is that the overall productivity of the equipment is not known in advance.

While projecting stationary automatic lines there are practically no restrictions of working area and weight of the technical equipment. The overall productivity of automatic line is defined by the customer at the first stages of projecting. If productivity of technological unit is not sufficient, its modernization is required. As a rule this involves the increase of its weight and dimensions. For maintenance of required productivity parallel structures are applied. It results in increase of weight and working area.

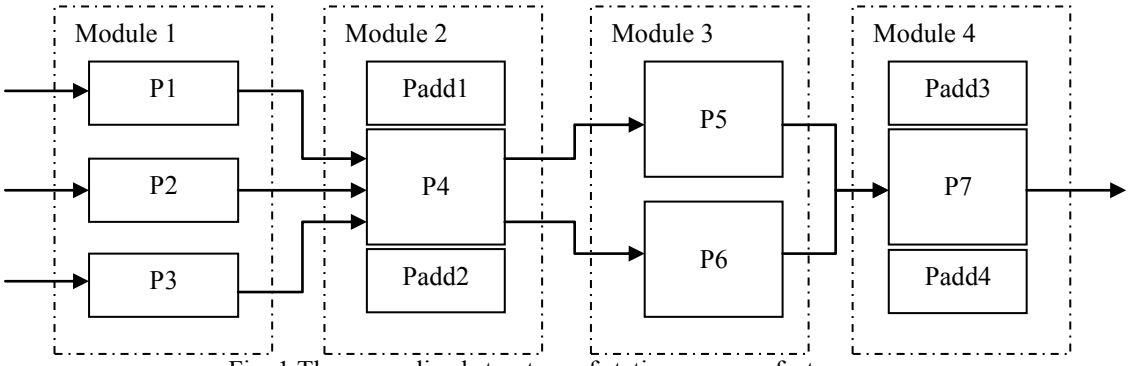


Fig. 1 The generalized structure of stationary manufacture
P1-P7 – Productivity of technological unit; Padd1-Padd4 – Productivity of additional technological units.

For maintenance of continuous material movement it is necessary to keep productivity of modules at the same level (fig. 1).
While projecting mobile systems another approach is applied. In view of restrictions on the geometrical sizes and weight of the equipment the slowest process is defined by manufacturing technology (fig. 2). The next step is to choose the equipment for its implementation.

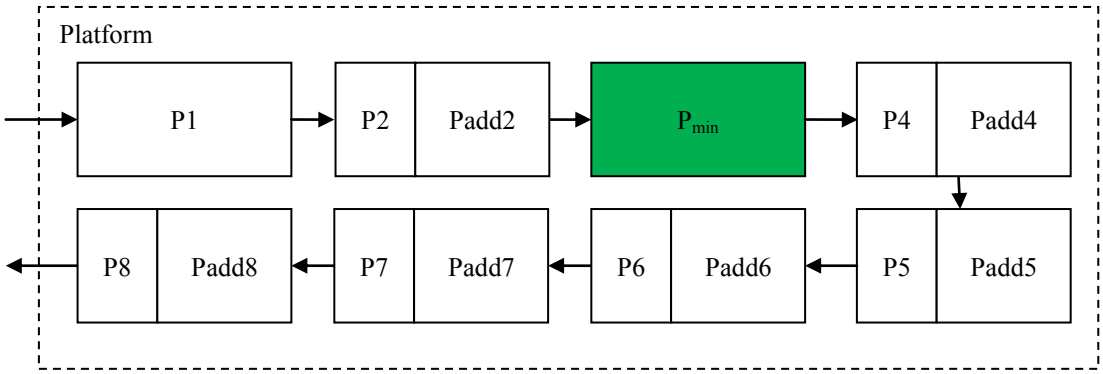


Fig. 2 The generalized structure of mobile manufacture
Pmin - a minifactory with the minimum productivity; P1-P8 – productivity of technological unit;
Padd1-Padd8 – Productivity of additional technological units

Modernization of the chosen manufacturing equipment occurs until its dimensions and weight will not exceed highest possible values. Its productivity is defined and this value is the basis for working out the structure of other technological units (fig. 3). Productivity of technological units should be the same as in stationary manufacture. Increase of the general productivity occurs at the expense of increase in quantity of flexible mobile automated lines (fig. 3).

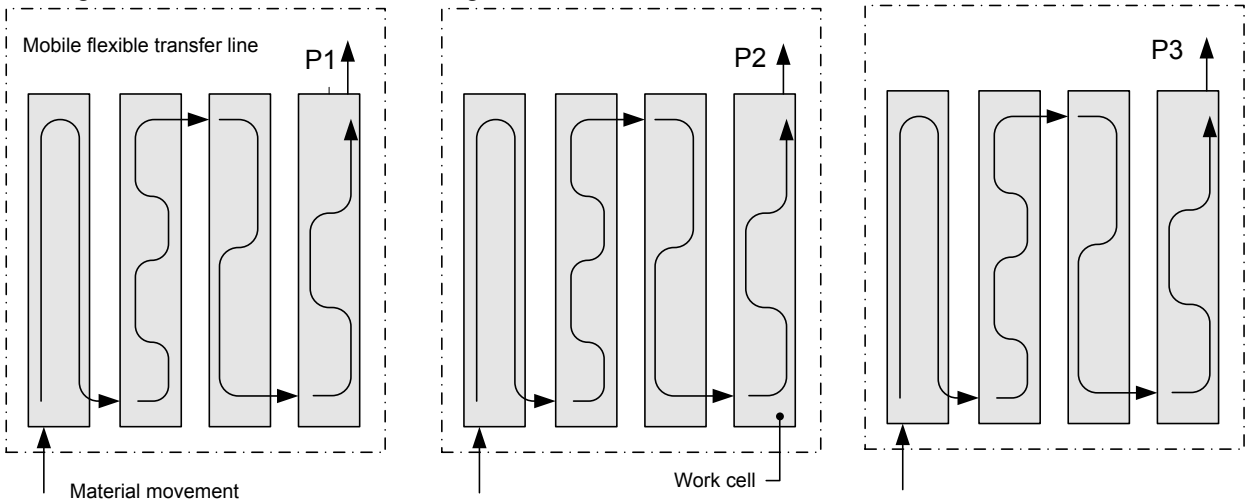


Fig. 3 General scheme of an arrangement of flexible mobile industrial lines
P1-P3 – Productivity of automated line

## 3. MOBILE – MODULAR MANUFACTURE OF FRAME WOODEN HOUSES

Four mobile platforms have been chosen for organization of in-line production of wooden panel houses. The process of projecting allowed forming chains of technological operations of the basic productions processes in the automated line.

Fig. 4 shows the arrangement of technological modules towards each other as well as material movement.

The basic technological processes are as follows:
- Preparation of prefabricated units of wooden panel;
- Manufacture of OSB-plates;
- Manufacture of a cellulose insulant;
- Assembly of the wooden panel;

The line for production OSB-plate as well as cellulose insulant is based on analogues of stationary high-efficiency transfer lines. It is integrated to the assembly line processing equipment.
The product line of assembly of the wooden panel is organized by modular principle. Each separate module represents the robotic work cell consisting of one or several robots. Considering features of the

assembly operations, all robots should have portal kinematic structure.

The assembly of timber-framing is made of ready modular wooden elements on a assembly tables. The fastening of modular elements is carried out by nailing together or special metal plates. Large size carcass is formed by timber-framing with the maximum sizes 3200×2000 (mm).

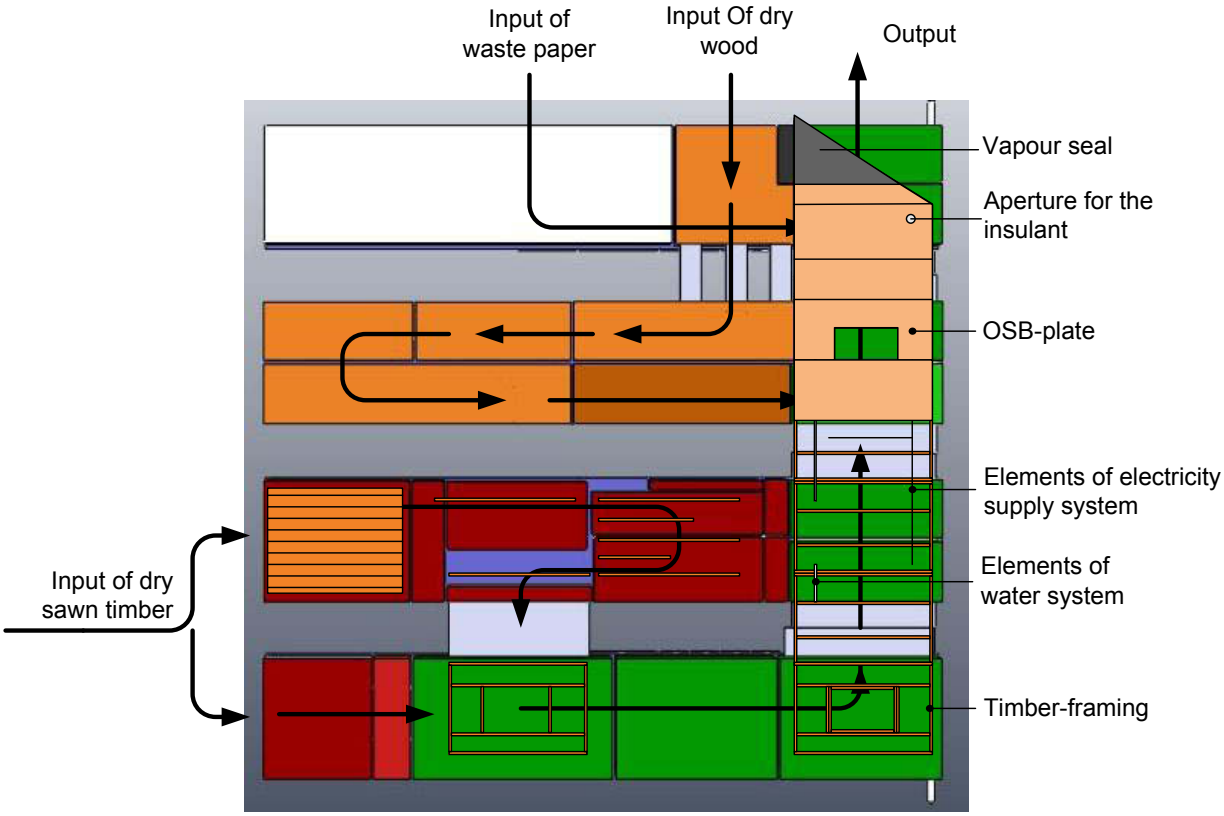


Fig. 4 Arrangement of the work cell

Further the timber-framing is moving in robotic work sell of installation of elements of water systems, heating and electricity supply systems. Except assembly portal robots the structure of robotic work cell includes the automated stores of assembly elements (plastic pipes, connectors, a network cable, distributors, network connectors etc.).

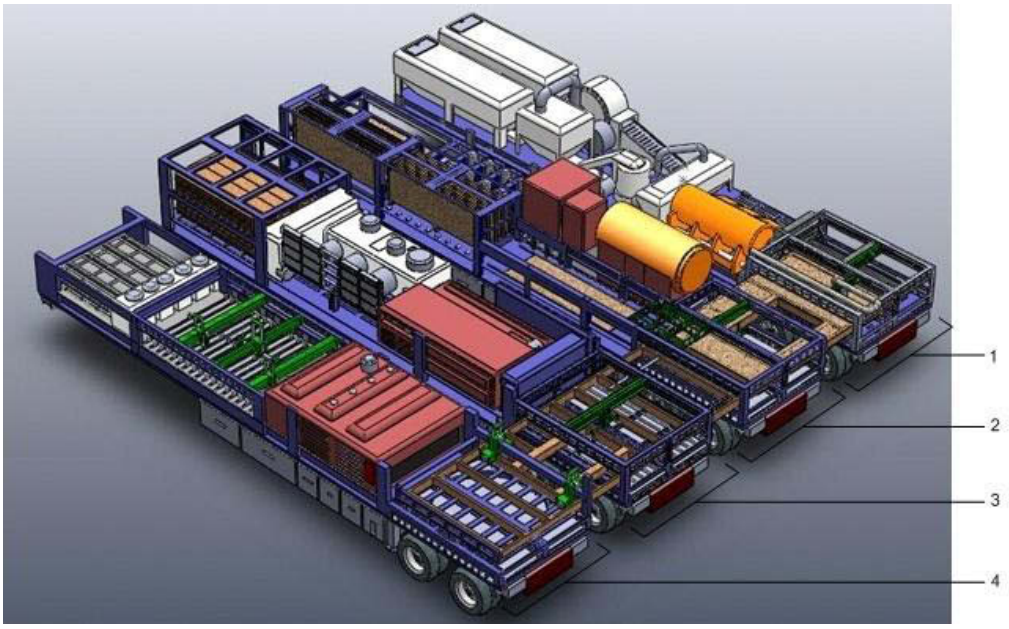


Fig. 5 Mobile flexible product line for manufacturing of elements of prefabricated wooden houses
1 – module of manufacture of a cellulose insulant; 2 – work cell of OSB-plates; 3 – module of preparation of modular elements; 4 – module of assembly of a timber-framing.

After installation of elements of armature, the carcass is moving to the input robotic work cell for laying internal and external covering OSB-plates. The module is equipped by four portal robots located both below and above the panel. The first pair of portal robots makes laying and nailing together OSB-plates with the timber-framing, the second – cut of window apertures and removal of unnecessary fragments of OSB-material. All these operations are made simultaneously for two sides of the panel. There is no necessity for using the canting table applied in stationary manufacture at present. Last technological operations is laying insulant, and waterproof membrane. All these operations are carried out at the last robotic work cell. It is equipped by three portal robots. The first portal robot carries out insulant laying. The cellulose insulant has been chosen as thermal insulating material. Insulant laying occurs as follows: in OSB-plate is made around aperture with diameter of 100 mm, cellulose wool (insulant) moves under pressure through the flexible pipeline into a panel cavity. Thus in the process of assembly the panel initially does not change the position. Laying the vapour seal is the final operation of panel assembly. The ready panel is unloaded and put to a trailer at once (fig. 5). It is necessary to note, that robotic work cell are arranged in a particular way: the output of one production module is the input of another. Technological process should be organized so that on an input of a line the dried up calibrated bar is loaded, and from its last site the building elements ready for assembly and the panels appear.

Thus, the scheme of an arrangement of work sell has the parallel structure at one end of which there is a supply of the calibrated bar and at the other there are - warehousing and an export place of assembly of finished goods. Installation of the whole automated line should take place on the desirable horizontal surface. Mobile-modular manufacture implies full automation of the whole chain of technological operations. Thus the quantity of attendants is reduced to a minimum. Only 2 people are required to control the service of one module, their basic duties include input of starting raw material (dry sawn timber and waste paper), supervision and adjusting in case of failure alarm. The important advantage of mobile-modular manufactures is the reduction of work area by means of technological equipment reorganization.

## 4. CONCLUSION

The mobile flexible automated manufactures are the highest achievement in the development of robotics. Their application in areas of building manufacture has repeatedly proved to be efficient . Panel wooden houses will become more available given the rational construction of the technological equipment and efficient organization of building cycle. As a result the following factors have been revealed: positive economic benefit of implementation of such line in the field of building manufacture (cost decrease of one sq. m), improvement of the quality of modular wooden houses due to full automation of technological processes.

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