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Generalized net model of manufacturing technology of bread and bakery products

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Abstract: In this paper, we introduce a generalized net that models the process of the bread preparation. The bread production is complex and time-consuming task. Its modelling can be used for monitoring and analyzing of the process from supplying with the initial materials to the valuation of the product.
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1 Introduction

The paper considers production of bread and bakery products. The first stage is supply of raw materials needed for each item. Next, all needed materials are mixed according to strictly defined recipe. The resulting mixture is called dough and after forming it rests in a special fermentation room. The next stage is an assessment of risen dough whether it is ready for baking or not. The good quality dough is baked. Quality of the product is checked. In case of poor quality, product has to be discarded and grinded to crumbs (for further use by restaurants, etc.). If the product is of good quality it is packed whole or in slices. The quality of the finished product is checked after packaging. At the end, the product with approved quality is ready to be sold to the market. In cases of discrepancy or expire it is sold as a revalued commodity.

2 The generalized net model

All stages of the bread preparation process will be represented as transitions of a Generalized Net (GNs, [1, 2]). The GN-model (see Figure 1) contains 7 transitions:

$$A = \{Z_1, Z_2, Z_3, Z_4, Z_5, Z_6, Z_7\},$$

where transitions represent:

- Z_1 – Supply of materials for articles.
- Z_2 – Mixing supplied materials (dough).
- Z_3 – Rising of the dough.
- Z_4 – Assessment of the risen dough.
- Z_5 – Baking.
- Z_6 – Cutting and packing of already baked product.
- Z_7 – Determination of the quality of product.

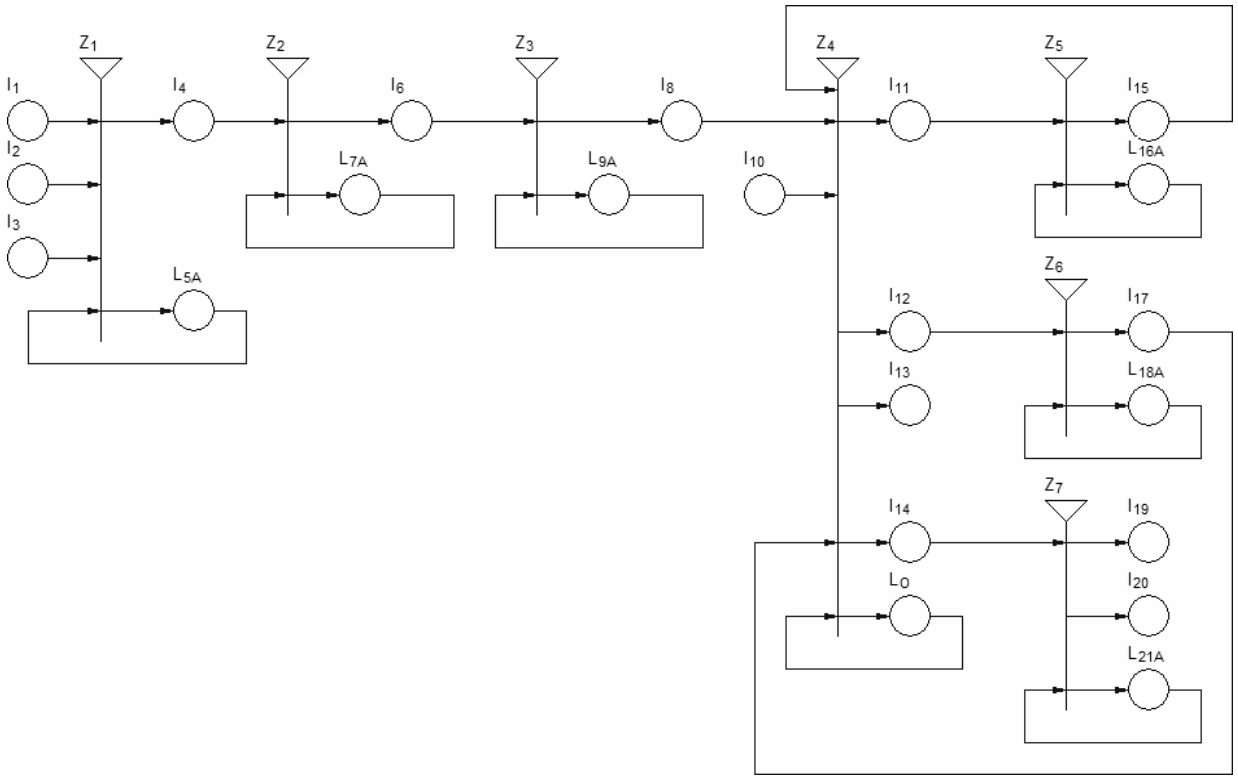

Figure 1: A generalized network modelling the bread preparation process

From places L_1, L_2 and L_3 enter tokens with characteristics, respectively, *"Characteristics of Flour"*, in place L_1, *"Characteristics of Salt"*, in place L_2, and *"Characteristics of Yeast"*, in place L_3.

$$Z_1 = \langle \{L_1, L_2, L_3, L_{5A}\}, \{L_4, L_{5A}\}, R_1, \vee(\wedge(L_1, L_2, L_3), L_{5A}) \rangle,$$

$$R_1 = \begin{array}{c|cc} & L_4 & L_{5A} \\ \hline L_1 & False & True \\ L_2 & False & True \\ L_3 & False & True \\ L_{5A} & W_{5,4} & False \end{array},$$

where $W_{5,4}$ = *"All products are available"*.

The tokens do not obtain any new characteristic in place L_{5A} and they obtain the characteristic *"Characteristics of Semi-cooked materials"*, in place L_4.

$$Z_2 = \langle \{L_4, L_{7A}\}, \{L_6, L_{7A}\}, R_2, \vee(L_4, L_{7A}) \rangle,$$

$$R_2 = \begin{array}{c|cc} & L_6 & L_{7A} \\ \hline L_4 & False & True \\ L_{7A} & W_{7,6} & False \end{array},$$

where $W_{7,6}$ = *"The dough is kneaded"*.

The tokens do not obtain new characteristic in place L_{7A} and they obtain the characteristic *"Dough"*, in place L_6.

$$Z_3 = \langle \{L_6, L_{9A}\}, \{L_8, L_{9A}\}, R_3, \vee(L_6, L_{9A}) \rangle,$$

$$R_3 = \begin{array}{c|cc} & L_8 & L_{9A} \\ \hline L_6 & False & True \\ L_{9A} & W_{9,8} & False \end{array},$$

where $W_{9,8}$ = *"There is a risen dough"*.

The tokens do not obtain new characteristic in place L_{9A} and they obtain the characteristic *"Risen dough"*, in place L_8. From place L_{10} enter tokens with characteristics *"Criteria for assessment of bread product"*.

$$Z_4 = \langle \{L_8, L_{10}, L_{15}, L_{17}, L_O\}, \{L_{11}, L_{12}, L_{13}, L_{14}, L_O\}, R_4, \vee(\wedge(L_8, L_{10}), L_{15}, L_{17}, L_O) \rangle,$$

$$R_4 = \begin{array}{c|ccccc} & L_{11} & L_{12} & L_{13} & L_{14} & L_O \\ \hline L_8 & False & False & False & False & True \\ L_{10} & False & False & False & False & True \\ L_{15} & False & False & False & False & True \\ L_{17} & False & False & False & False & True \\ L_O & W_{O,11} & W_{O,12} & W_{O,13} & W_{O,14} & W_{O,O} \end{array},$$

where

- $W_{O,11}$ = *"The dough is approved for baking"*;
- $W_{O,12}$ = *"The bread product is quality baked"*;
- $W_{O,13}$ = *"There is bread product ready for packaging"*;
- $W_{O,14}$ = *"There is bread product evaluated as revalued"*,
- $W_{O,O}$ = *"There is a product for evaluation"*.

The tokens do not obtain new characteristic in place L_O and they obtain the next new characteristics in places L_{11}, L_{12}, L_{13} and L_{14}, respectively, *"Characteristics of dough, approved for baking"* in place L_{11}, *"Characteristics of baked bread product"* in place L_{12}, *"Characteristics of ready bread product"* in place L_{13}, and *"Characteristics of revalued bread product"* in place L_{14}.

$$Z_5 = \langle \{L_{11}, L_{16A}\}, \{L_{15}, L_{16A}\}, R_5, \vee(L_{11}, L_{16A}) \rangle$$

$$R_5 = \begin{array}{c|cc} & L_{15} & L_{16A} \\ \hline L_{11} & False & True \\ L_{16A} & W_{16,15} & False \end{array},$$

where $W_{16,15}$ = *"Bread product is ready for baking"*.

The tokens in places L_{15} and L_{16A} obtain characteristic: *"Characteristics of baked bread product for assessment"*.

$$Z_6 = \langle \{L_{12}, L_{18}\}, \{L_{17}, L_{18}\}, R_6, \vee(L_{12}, L_{18}) \rangle$$

$$R_6 = \begin{array}{c|cc} & L_{17} & L_{18} \\ \hline L_{12} & False & True \\ L_{18} & W_{18,17} & False \end{array},$$

where $W_{18,17}$ = *"Bread product is ready for cutting and packing"*.

The tokens in places L_{17} and L_{18} obtain characteristic: *"Characteristics of sliced and packaged bread product"*.

$$Z_7 = \langle \{L_{14}, L_{21}\}, \{L_{19}, L_{20}, L_{21}\}, R_7, \vee(L_{14}, L_{21}) \rangle$$

$$R_7 = \begin{array}{c|ccc} & L_{19} & L_{20} & L_{21} \\ \hline L_{14} & False & False & True \\ L_{21} & W_{21,19} & W_{21,20} & False \end{array},$$

where

- $W_{21,19}$ = *"Bread products are revalued for breadcrumbs (restaurants, etc.)"*;
- $W_{21,20}$ = *"Bread products are revalued for bargain-sale"*.

The tokens in places L_{19}, L_{20} and L_{21} obtain characteristic, respectively, *"Bread products revalued for breadcrumbs (restaurants, etc.)"*, *"Bread products revalued for bargain-sale"*, *"Bread products for processing"*.

3 Conclusion

The purpose of this paper is to show how GNs can be used to model the process of preparing the different types of breads. It is the first GN-model in this field. Since the processes are complex and time-consuming, the model has not been described in many details, yet with sufficient information to apply it in practice for monitoring of the process. Different types of materials take part in this process and it has to be observed by different binding requirements and restrictions.

The constructed model can be used for analyzing of the process, as well as expanding it by adding additional parameters as characteristics of tokens, which will allow its optimization.

References

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