ABOUT THE METHODOLOGICAL BASES OF THE PROBLEM FOR AN IMPROVEMENT OF AN EXISTING SOLUTION

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Abstract: *The engineering task - to improve the existing solution starts when, during the cycles of manufacturing or intended use of a technical system, it appeared preconditions for achieving better results. Although the problem is common for the engineering practice, there is no generally accepted model (algorithm) for its solution. For the harvesting of soy crops and other row crops in the country headers HPS are widely used, which are manufactured at METAREM - AD Pavlikeni. For the past more than thirty years since the start of mass production, headers passed their long path of development and improvement. Through the analysis of the collaboration of TISEM - AD, Ruse and METAREM - AD in the improvement of headers HPS, the types of activities and the content of the work are clarified. On this basis, is proposed a model (algorithm) to solve the engineering task to improve the existing solution, which covers all the activities of the design process.*

Keywords: DESIGN PRACTICE, HEADERS FOR HARVESTING, SOY CROPS, DESIGN MODEL

1. Introduction

All fundamental researches on design of technical systems that came out in the end of XX and the beginning of XXI century define the task for the improvement of the existing solution as one of the main tasks of the engineering practice [6,7,8,9,10,11,12]. At the same time a research into methods for solving this problem are found rarely in scientific periodicals. This is due to the fact that the scope and content of the task - improvement of the existing solution are modified within wide limits. The problem can be defined at the level of system for conversion of matter, energy and information, an element of it is the improved technical system, so that the improvement would cover the entire design process. On the other hand, the problem can be defined at the level of a technical system and the improvement would cover the executive organs of the technical system. Thirdly, the task can be defined at the level of an executive organ of the technical system and the improvement would cover the structural elements that build the advanced executive unit. The lowest level at which can be defined the task of improving the existing solution is the constructive element. In this task the construction element - the lowest standing unit in the composition of the technical system is put under improvement.

As a result of an earlier study a generalized model for designing of technical systems has been proposed. It is obtained by combining (superimposition) of the models (algorithms) to solve the four main tasks, defined within the framework of this study – an adaptation of an existing (turnkey) solution to work in new conditions, an improvement of existing (turnkey) solution, a combination with precast or a creation of a new solution [4]. Based on this basic model is proposed a model (algorithm) to solve the engineering task of improvement of the existing solution. The content of the model (algorithm) is explained on the basis of the analysis of the joint work of TISEM - AD, Ruse and METAREM - AD Pavlikeni, on improving headers for soy plantings HPS. Headers are created in connection with the introduction of a technology for row harvesting of soy crops in Bulgarian agricultural production. For the past more than thirty years since the start of mass production of METAREM – AD, headers for soy crops HPS have passed a long path of development and improvement.

2. An analysis of the collaboration of TISEM - AD and METAREM - AD on the improvement of headers HPS

The multiple tests inland and abroad and widespread use in Bulgarian agricultural production have proved the effectiveness of row headers HPS in harvesting soy crops and other row crops planted at a spacing of 70 cm. The results of the tests and the recommendations given by the farmers and the implemented control have shown that among the positive aspects there are certain doubts about the improvement of the design of headers HPS and about the improvement of their technological capabilities. From the information gathered it was clarified that by increasing the speed of the combine harvester more than 5 km/h, the cutting height of plants has significantly increased and there appeared some disturbances in the technological process, flowing in particular working sections.

The collaboration between TISEM - AD and METAREM - AD on the improvement of row headers HPS has started with the systematization of the determined shortcomings and grouping them according to the scope and their complexity. On this basis technical assignment has been defined and approved. Based on the technical assignment and the main and complex disadvantages, changes have been made to the existing technical proposal and the outcome is an adjusted technical proposal. In carrying out the next step the adjustments of the technical proposal reflect on the conceptual design. The process continues with changes at working section-level and ends with the changes of the smallest scope and complexity – construction item-level. The detailed design includes strength calculations and verifying the structural and functional linking only of the changed components at the different levels. All the changes reflected in the technical documentation. Based on the adjusted technical documentation, an improved experimental model has been produced and tested.

Fig. 1 *Row header for harvesting soybeans HS*

The preparation for production continues with completion of the technological equipment and later on with production, and testing of a zero series. Following the successful implementation of all stages of preparation for production, the mass production of new family of row headers for harvesting soy plantings HS by METAREM - AD is reached (Fig. 1). The new family of row headers HS has the

following advantages, compared to the basic family HPS: the number of simultaneously collected rows has been increased from six to eight; the working sections are driven in groups (in two) from intermediate shafts to which protective clutches are built; by a V-belt variable transmission the speed of the chain belt conveyors, the angular velocity of the disc cutter of the working sections and the forwarded speed of the combine harvester have been synchronized [2].

Concerning the improvement of the working section the following changes have been made: the frame of the working section has been light-weighted; the cutter has been shifted forward and to the counter-knife a second cutting edge [3] has been designed; under the counter-knife an unit for deviation of stems has been placed, that directs by force the plants to the cutting zone; the range of copying the work section from 150 to 200 mm has been increased; by a cylindrical spring, mounted on the vertical shaft of the cutter, the minimum clearance of cutting is ensured; the backlash in the gears of the transmission of operation sections is variable adjusted; the working section is locked when the header harvests sunflower and corn.

3. A model (algorithm) for solving the engineering task for the improvement of an existing solution

The performed analysis of the collaboration between TISEM - AD and METAREM - AD in the improvement of row headers for harvesting of soy plantings HPS is the basis of the proposed model (algorithm) for solving the engineering task for the improvement of the existing (turnkey) solution (Fig. 2). The model is presented as a solved task on the basis of the previously created generalized model for the design of technical systems obtained by combining (superimposition) of the models (algorithms) for solving the four basic design problems. The generalized model itself is a part of the developed models for the presentation of the hierarchical comparability between the life cycle of the technical system, the technical preparation for production, the engineering preparation of production and design, resulting from earlier studies [1, 5]. The steps that form the structure of the model (algorithm) for solving the engineering task for the improvement of the existing (turnkey) solution are highlighted in dark in Fig. 2.

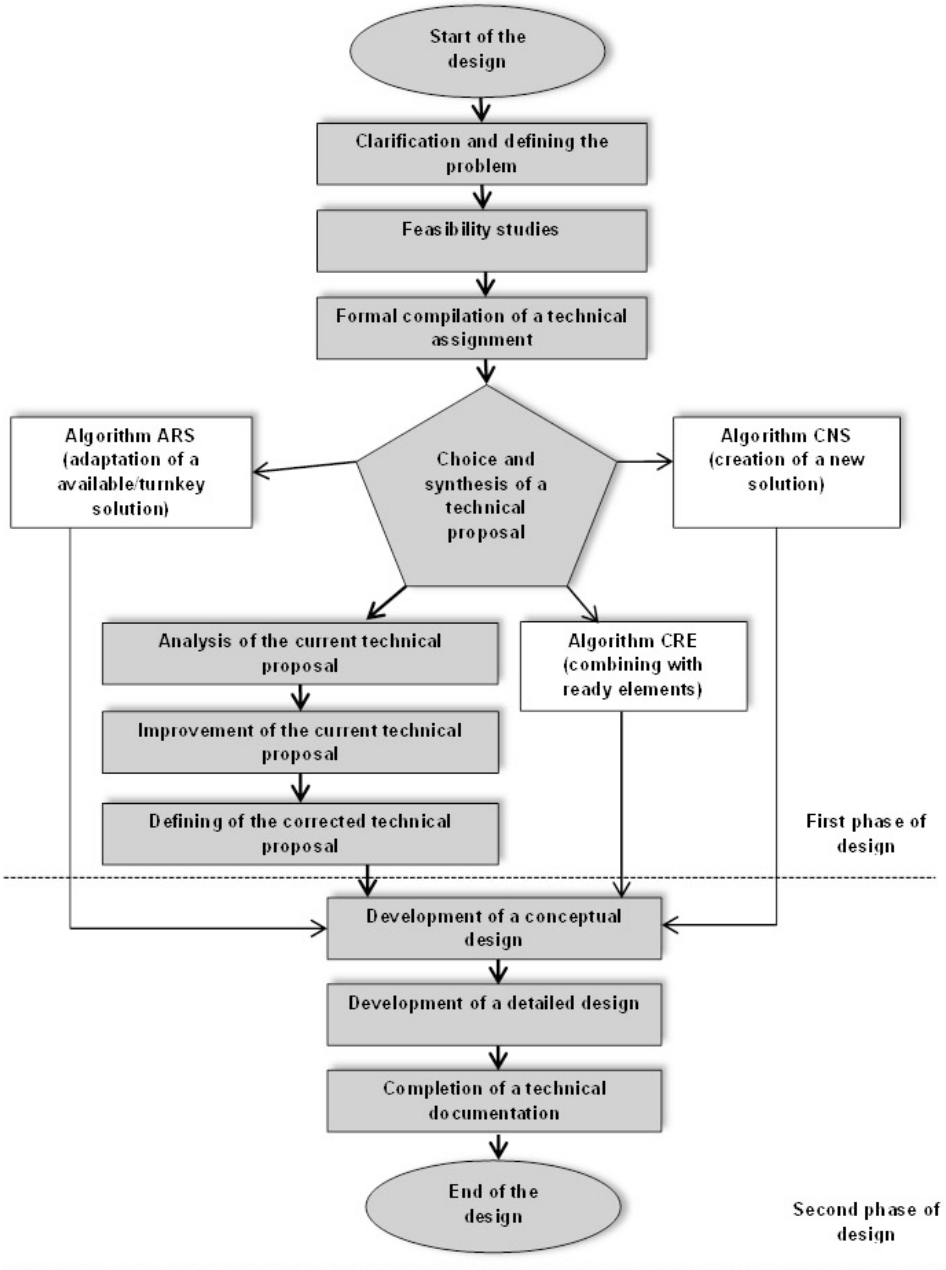

Fig. 2 *A model (algorithm) for solving the engineering problem of adapting of an existing (turnkey) solution to work in new conditions*

The design process begins with the implementation of the first three steps of the basic model - clarifying and defining the problem, conducting feasibility studies and preparation of the technical assignment. The specificity of the solved problem defines the different content of activities in this early stage of design. As revealed by the analysis performed, after justification of the need to improve headers HPS, the next step is to analyze the results of the tests carried out, the recommendations of the farmers and the information gathered by the implemented control. Then the identified disadvantages are systematized and grouped according to their scope and complexity. On this basis, the technical assignment has been drawn up and approved.

The specificity of the task for improvement of the existing (turnkey) solution is the basis for the variety in the selection or synthesis of the technical proposal. The corrected technical proposal is based on the following sequence of actions – the shortcomings from largest range and complexity are systemized, the existing technical proposal has been analyzed, the existing technical proposal has been improved and finally the corrected technical proposal is defined.

By reflecting the adjustments of the technical proposal in the preliminary (conceptual) design, a transition is made from the first phase (functional) to the second phase (object phase) of the design (Fig. 2). The detailed design is essentially a multiple solving the task of making changes with varying scope and complexity of the constituent parts at the different hierarchical levels. The analysis of the improvement process of headers for soy crops HPS shows that regardless to the scope and complexity of the changes, the problem is solved by the same methodology - the need for such alteration is justified, the current situation is analyzed, the desired change is performed and the change made are reflected in the technical documentation. From the analysis of the process of improving the headers it became also clear that to justify the changes needed, in some cases it was necessary to use research methods [2,3]. Strength tests and verification of structural and functional linkage are applied only to the changed parts. The design ends with a reflection of the changes in the technical documentation. Based on adjusted technical documents, the next step of preparation of production is performed.

4. Conclusion

Through analysis of the collaboration between TISEM - AD and METAREM - AD on the improvement of the headers HPS, are clarified the types of activities and the content of the work done. On this basis, a model (algorithm) for solving the engineering task for improvement of the existing solution, which covers all the activities of the design process, is proposed. The model is presented as a solved problem on the basis of a previously created generalized model for the design of technical systems obtained by combining (superimposition) of models (algorithms) for solving the four basic tasks of the engineering practice – an adaptation of existing (turnkey) solution for work in new conditions, an improvement of a turnkey solution, a combination with precast or creation of a new solution.

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