VOL. 11, NO. 9, MAY 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

DEVELOPMENT OF AUTOMATED DISPATCHING CONTROL SYSTEM FOR CONCRETE BATCHING PLANTS

Andrey Ostroukh[1], Peter Yurchik[1], Nataliya Surkova[1], Aleksander Kolbasin[1] and Dmitry Moroz[2]
[1]Department of "Automated Control Systems", State Technical University-MADI, Moscow, Russian Federation
[2]Department of Road Transport, State Technical University-MADI, Moscow, Russian Federation
E-Mail: ostroukh@mail.ru

ABSTRACT

In the article proposed the scientific approach to the problem for automation transportation planning construction materials in the two-tier control system. It is shown, that for a rational solution of the problem of transportation planning construction materials must use data mining methodologies and expert systems to assess the probability of the task. Automated Dispatching Control System (ADCS) has a layered structure, and may include multiple geographically distributed plants connected into a single technological system integrated into the enterprise management system. The proposed system is scalable and can include management subsystem concrete plants, air traffic control, laboratory, hydrothermal treatment, weight management, warehouse aggregates and cement, concrete targeted distribution, access control subsystems, jobs management personnel.

Keywords: concrete products, concrete batching plants, transportation, construction materials, data mining (DM), expert systems, data warehouse (DW), OLAP, OLTP, automated dispatching control system (ADCS).

1. INTRODUCTION

Currently, when developing a competitive relationship in the construction of residential high-rise buildings in the city, requires new solutions in the field of marketing transport to the expansion of the list of suppliers of construction materials. It should be formulation and formalization of the planning and regulation of the delivery of Concrete Products (CP) to construction sites [1-10].

The construction of important objects of civil and industrial construction requires considerable amounts of concrete, which are able to provide a high-performance concrete plants.

Process Control Production of concrete mixtures is currently impossible without the use of modern automated systems developed by using modern controllers and software [1-19].

Center dispatch control road transport CP solves the problem of shift-day planning of rolling stock for the delivery of products on construction sites from House-Building Factory (HBF). Delivery shall be performed in accordance with planned hourly chart CP shipment from HBF (assembly graphs) - the first control level.

A separate problem is the operational control - correction of shift-day plan for delivery of a CP in real time and coordinate the work of managers of motor transport enterprise. These activities are performed at the second control level.

In the study on the feasibility of upgrading software formulated a strategic goal - improving the efficiency of the planning and operational management of delivery trucks CP tracking modes of the rolling stock and the issuance of recommendations for targeted reasoned impacts on operations for the entire transport chain [11, 12]. Currently, the argument can not be precise impact of formalization, that is, the controller on the basis of known only to him precedents and operational factors holding rescheduling of individual units of rolling stock, which entails the adoption of arbitrary decisions.

2. BACKGROUNDS

Using traditional approaches, select the characteristics of solutions interrelated tasks two-tier control system for transportation concrete products (Figure-1):

- collection, compilation, analysis of data on the implementation of the work of rolling stock on the routes on the basis of monitoring in real time or, alternatively, in the mode after the fact, with the preparation of a daily report to the control room service logistic company (second control level) to enable more rapid take selection alternative control action on the disturbances in the system of delivery of CP;
- processing of information on extraordinary situations in the delivery process in order to take the leadership of logistic company and CP-making plants for the preventive measures, neutralization and elimination of the consequences of such situations;
- prompt submission of data on the state of roads and facilities on routes of delivery CP - to make basic information on the operational modes of traffic units of rolling stock;
- ensuring the registration and archiving of completed routes with accommodation "purified" of information in the Data Warehouse (DW) and automation support queries in the process of retrospective analyses to account for previously identified error conditions and unreasonably high (or understated) standardized indicators, in particular, the run-time routing tasks.

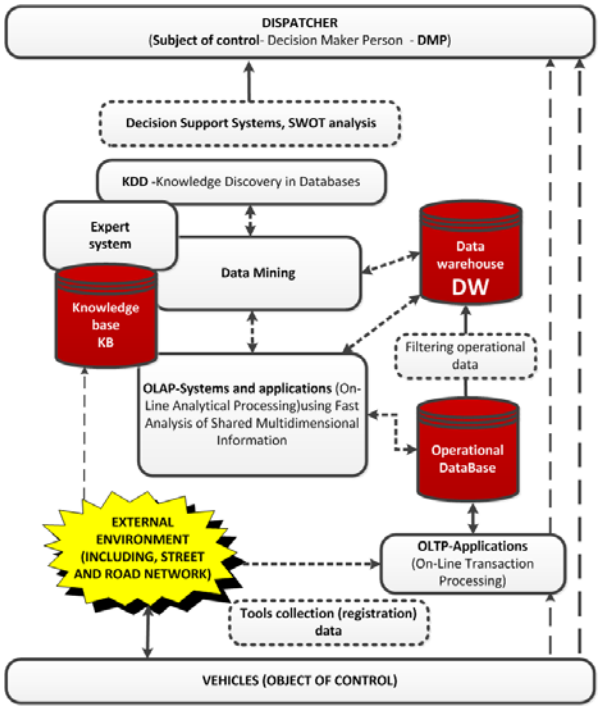

Figure-1. Schematic diagram of the in-system component interaction information-analytical system for Dispatching Control of Transportation Concrete Products.

Solution of these subtasks will require an integrated approach [1, 15-25]. For example, the selection of works on automation planning of rolling stock from the list of tasks in the information-analytical system will lead to insignificant effect. In this case, not be affected by organizational and industrial relations in the two-tier control system.

3. MODELS AND METHODS

Among the priority tasks to be automated, can be attributed the rapid implementation of the overall monitoring and guiding the work of dispatchers of branches with bringing the decisions taken to subordinate structures.

Formalize the task of planning road transportation in a particular setting. In Figure-2 is a diagram of the implementation of the transport operation.

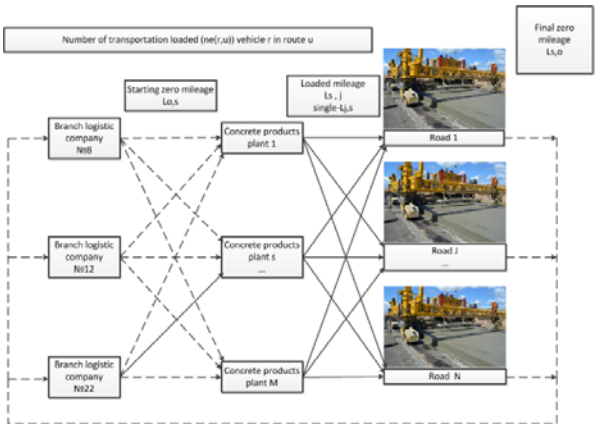

Figure-2. Driving performance of the transport operation.

Formation of the consignments carried out in accordance with an algorithm based on the specified load restrictions on the carrying capacity of the vehicle. A feature is the presence of solutions of different models of rolling stock, wherein the process of formation is directly related to feed a certain vehicle under loading at a predetermined time interval.

Review of existing software for the automation of work of dispatchers logistic company presupposes the existence of an incomplete set of software and tools solve subtasks. Used methods of automation of computing operations, reporting, some methods of optimization of route and route network delivery.

Scientific achievements offer a variety of single-pass algorithm for calculating the modification. One realizes repeatedly described method of constructing a "time delivery schedules." In fact, the set of approximate algorithms represent a heuristic approach to planning rolling works manager, when the processes of formation of shipments carried out in parallel with the calculations of shift-day tasks units of rolling stock. Iteration-step procedures of decision-making, standard rules described solutions follow each other. At each step change in the state fixed delivery system, which is expressed in the adoption of appropriate solutions for the specific unit of the rolling stock with the appointment of a shift-specific daily task dispatch.

Invariant approach - step by step implementation of a two-stage, iterative algorithm, when the first phase based on the results of the comparative analysis of applications for the transportation routing tasks are formed by the criterion of complete coincidence trace route into the data warehouse.

In this case, we can talk about a particular embodiment of the use of Data Mining application that allows to detect useful knowledge in historical data with a mandatory update them (check on the ability to perform previously made the route with the current situation on the road network). The process of search for knowledge - Knowledge Discovery in Databases (KDD) [1] is performed using the calibrated mathematical rules is implemented as software and is functionally completed module of Decision Support Systems (DSS) [1].

In the second stage to make consistent efforts to calculate the routing assignments for each piece of rolling stock and presentation manager of one of the many possible alternatives timetable for rolling stock using the mathematical apparatus (as a rule, the mathematical formulation of the problem, which reduces it to a system of equations by methods of integer linear programming).

As a result of program-level and comparative analysis of the performance of shift-day rolling work plans prepared as using these scientific approach, and the proposed approach. It is proposed to obtain acceptable solutions without involving difficult formalized rules do not require undue effort from the dispatcher in the process of reflection and in the planning process will be possible to assess the advantages (disadvantages) in the task.

4. SYSTEM APPROACH TO THE DEVELOPMENT OF A CONCRETE BATCHING PLANT AUTOMATION

In accordance with the methodology of systems engineering work on the creation of concrete plant automation will divide into stages and steps.

At the first stage we formulate the goal of the system. ACS concrete plant is designed for effective control and management process, from submission of materials from warehouses and ending with the delivery of the concrete mix to consumers. The purpose of control - increased efficiency, rhythm and quality of production, the timely provision of the necessary number of consumers mixtures settings.

In the second stage of the system analysis to delimit the system under study. Specifies that the system should include the management of the following processes: supply of materials from warehouses in capacity over the bunker separating dosing concrete mixture, issuance and delivery of ready-mixed concrete in the molding stations. Molding and other areas that consume the concrete, as well as rail and road transport, delivering the components of concrete warehouses, are not included in the system and can be attributed to the environment. It is assumed that in the operation of the system receives the orders for the concrete mix (with points of consumption), and the components of the concrete mix (warehouse cement and aggregates).

Thus, the external environment influences on the system. The influence of the external environment is neglected.

As a result, the primary structuring elements stand out the process to be automated management, as well as inputs and outputs that connect the system under consideration and the environment.

In the third stage of system analysis pre develop a mathematical model of the system. At this stage, limited to image and verbal description of subsystems and communication function.

Given the natural structure of the process, we conduct its decomposition into sub-processes (Figure-3).

In accordance with the decomposition process in the sub-decomposed management tasks into subtasks (difficulty level decision makers).

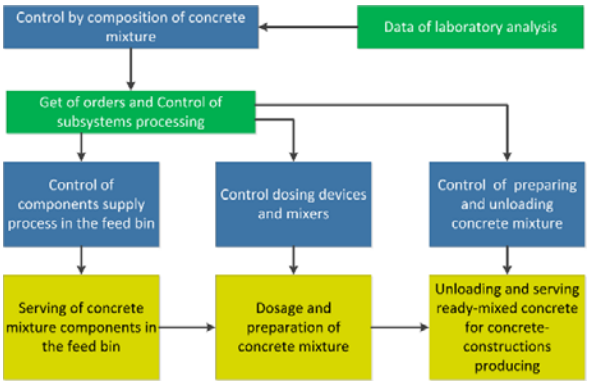

Figure-3. Control tasks for concrete batching plant.

The overall objective of the control process as a whole is divided into a series of consistently solve simpler problems (see Figure-3). First, on the basis of laboratory analysis established percentages of components in concrete mixtures of different brands, taking into account humidity and debris aggregates, cement activity and so on. The results of this task are the initial data for the solution of coordination of subsystems in accordance with the orders for concrete mix, coming from environment. Based on the data queue of orders and results of solving the problem of the control structure, defined job dispensers and mixers, chain selected vehicles, delivering the finished concrete mixture to the consumer, supply bins are determined to be downloaded.

Further, preliminary design is carried out and the choice of the technical means control system (Figure-4).

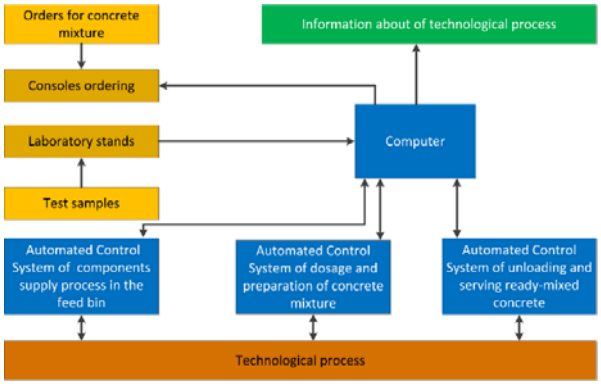

Figure-4. Model ACS for concrete plant.

Based on these stages of systems analysis work is distributed among individual performers, compiled schedules for completion of design and research works.
In the future for a number of sub-systems are drawn up more detailed mathematical models. In this transition function, outputs, binding functions are described in the form of mathematical expressions, which allows you to explore a variety of control algorithms by numerical simulation on a computer.

At receipt in the concrete component weighbridge tracking error mass change of material in the hopper of the dispenser because of the transient is large.

After closure of the dosing process and damping of transient weight of each component can be measured with greater accuracy. If it turns out that the components of the vector of percentage deviation is beyond a certain tolerance range, select the type of component and the corresponding dispenser dosing. After the implementation of the selected dosing procedure is repeated until the line is in principle the interactions vector percentage deviations will not be in the predetermined region.

5. AUTOMATED CONTROL SYSTEM FOR CONCRETE BATCHING PLANT

In Figure-5 shows the control system [14-16, 19] concrete plant concrete mixing two nodes. Control the process of mixing and dispensing an order proposed to take place with the help of programmable logic controllers (PLCs).

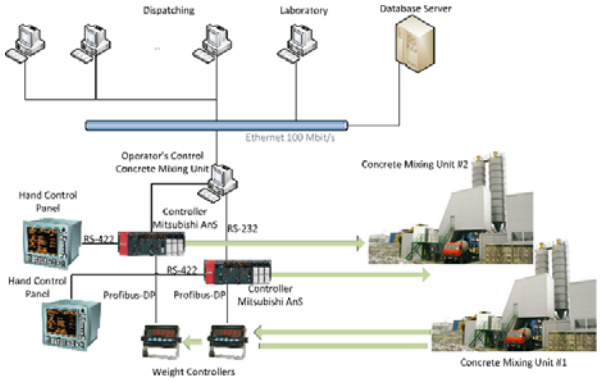

Figure-5. ACS for concrete mixing units.

The controller performs the following functions:

- process the data received from the sensors and actuators on the basis of which are managed;
- provide a communications interface for visualization of the technological process at the operator's station;
- return the factual information about the order.

All the resulting data with the time of the order are sent to the program flow control vehicles, as well as a statement accompanying documents.

The system allows for different kinds of statistics:

- current - the number of shipped product (m3) from the beginning of the change;
- monthly - for the costs of raw materials, with the transfer to the company's network.

Use the menu bar, you can get more information on each of the sites and to organize work with lists of alarms and process messages. This allows the operator to control the operation of the system, follow the failure of the process equipment and prevent accidents.

All the technological process is displayed on the operator's station, which is divided into two parts, relating to different nodes. Also at the bottom of the screen is a menu bar and alarms.

All operator actions and failures of process equipment are recorded. In addition, it formed a database of results for each order dispensing with the preservation of information about the time of execution of the order and the amount of raw dosing materials.

In case of failure of the operator station provides a backup control channel from the operator panel (console).

The system includes a number of flexible configurable parameters set in the configuration utility. With their help, you can fine tune the different delay times, weight thresholds, and so on dosing parameters:

- to avoid splashing the product implemented regimes of fast and slow discharge. The developed system is able to "learn" and to compensate the error of dosing previous downloads. The system uses several multi-component dispensers;
- use an adaptive algorithm dosing "Coarse / Fine", which allows to achieve high accuracy of dosing;
- provides an introduction to the system of new components and operational correction prescription content of individual components of the moisture content;
- to upload the components to the mixer may vary depending on the season;
- realized heated inert components, which together with the adaptive allows the addition of hot water to bring ready-mixed concrete to the desired temperature;
- flexible distribution of the components of the feed bin, depending on their completion.

6. RESULTS

Test cases have shown the prospects of further work on improving the software. The development of modernized software involves integrating it as a module in real-time monitoring and control of the work of rolling stock. Currently, more than 100 units of rolling stock equipped with global positioning systems and two-way communication between the vehicle and the Dispatch Control Center road transport of concrete products, which performs the functions of planning and monitoring traffic.
If you dwell on the theoretical aspects algorithmic support weakly formalized tasks, it should be noted that the current practitioners as theorists note the presence of scarcity of expertise in the design and use of modern methods and means of automation of processes of generation alternatives, in particular, to solve the problem rationalizing the choice of control action. But this experience, whatever it may be, is essential to ensure the development, at least at the level of general formulation and solution of the problem of software implementation planning module (operational rescheduling) traffic CP.

Traditionally used in the design of the "hard" mathematical models and algorithms are not fully adequate facility automation - process control loop road transport CP by dispatching service level, and do not allow to fully formalize the professional knowledge of decision-

makers. In many studies, mostly foreign scientists formed the direction of Soft Computing [26, 27] combines:

- synergetic effect of probabilistic reasoning;
- theory of fuzzy systems;
- theory of neural systems and methods of evolutionary modelling.

The natural conclusion - a proposal for the design of the upgraded software planning vehicles for the transport of CP with elements of data processing systems and knowledge, or the use of design techniques Expert Supporting System for Decision-Making Process. According to the classification of intelligent information systems for other purposes, the system can be attributed to the group of intelligent software.

The software module generation solution offers a set manager acceptable alternative solutions. Selection of a particular generation algorithm depends on how the description of rules and the completeness of the information available to the Manager of the stochasticity of the processes, primarily time traffic units of rolling stock on the routes and times of operations of loading / unloading.

7. CONCLUSIONS

The full implementation of the project to develop integrated software involves information exchange in automatic mode with the hardware-software complex dispatcher's logistic company branches and factories CP on the basis of standardized protocols and exchange formats. Completed implementation of the program at the level of the converter matching database formats in a two-tier control system. It is noted that the legacy software that offers hours of direct shipping schedule CP, functional can not be involved in the modernized complex system fully. This operation planning module of the second level of control at the level of basic performance calculations shift-day plan should be provided both in the presence and in violation of channels of communication with external users (the first level of management).

Acceptable option of upgrading the software - implementation of the concept of "rapid prototype" that is, the creation is not the final product, and a prototype software in less time to design and relatively small other resource costs to the future design of specialized software module for filling the storage array data "precedent "and testing" smart "algorithmically verified, methods of solving the problem of a two-phase plan.

Bringing the prototype is scheduled to perform on the basis of some expert system is well-proven in practice. Typically, in this case of the prototype expert system components are removed, too specific to its domain and retained those which have no specialization.

According to the results of trial operation, as has been noted, in practice, it may be necessary modernization (modification) of the system, not only the basic software, but also the restructuring logical data scheme, and bringing the I/O data in accordance with the requirements Technology for automatic processing of information about the location of vehicles. It can be foreseen, but to take any preventive measures without going through extremely difficult period of trial operation.

By improving the quality and ergonomics of work the operator is expected to increase technological discipline it is also important complete recording of all events occurring in the system, including the actions of the operator.

The accumulation of the results of raw materials and consumable materials enables statistical analysis and "close the loop" circulation of raw materials and finished products at the plant, as well as generate reporting and records of the results of the concrete mixing plants for different time periods.

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