



*Engineering calculations of any
complexity*

*Industry X.0
Digitalization*

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Industries of completed projects

INDUSTRY X.0
(DIGITALIZATION)

CONSTRUCTION

EXPLOSION SAFETY

PREVENTING CATASTROPHS

OIL & GAS

> 2700
successful projects

MECHANICAL ENGINEERING
(INCL. HEAVY)

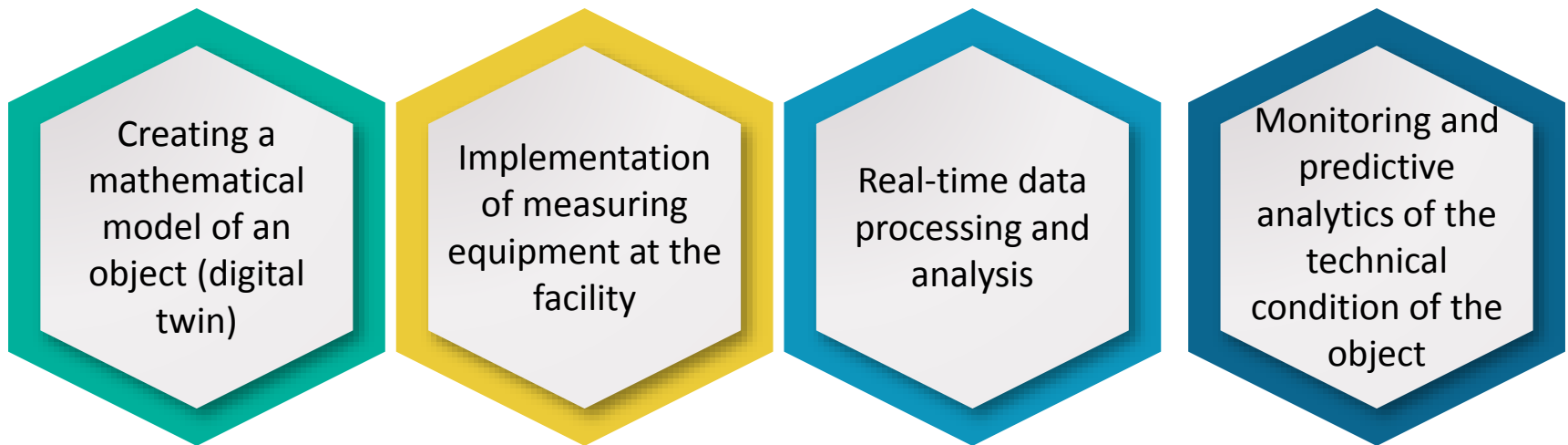
RAILWAY and AUTO

IARCRAFT and
SHIP BUILDING

Elements of Industry X.0. Digitalization

The use of modern methods for construction of digital twins, implementation of various sensors into a controlled object and analysis of data allow us to build predictive models of the object's behavior over time.

Digitalization Steps



It is **impossible to implement predictive analytics without creating the most detailed and accurate mathematical model** of the controlled object. Moreover, the number of sensors and the complexity of the calculations during data processing do not play a special role for the formation of possible technical conditions of the object.

APPENDIX

Examples of work performed.
Industry X.0

Development of a monitoring, analysis and predictive analytics system for a potentially dangerous railroad transport facility (1/4)



The monitoring system is designed for centralized collection, processing and provision of predictive analytics about the technical condition of potentially dangerous objects.



The monitoring system consists of:

- hardware complex of measuring, telecommunication equipment, which is installed on a controlled object;
- a software complex that collects all the data coming from the hardware complex;
- software complex to continuously monitor the state of the controlled object and real-time scheduling;
- a software complex of predictive analytics that analyzes data coming from the aggregator and forms a set of recommendations.



The Komsomolsky bridge across the river. Ob, Novosibirsk. The length of the bridge is 916 m



Development of a monitoring, analysis and predictive analytics system for a potentially dangerous railroad transport facility (2/4)

The basic composition of the measuring sensors

- **Navigation receivers** are used to measure the level of movement of structural units in space.
- **Strain gauges** are used to measure the level of stresses at control points of structural elements.
- **Linear displacement sensors** are used to measure the level of relative displacements of structural elements.
- **Angle sensors** are used to measure the level of deviations of structural elements in space.
- **Vibration sensors** are used to measure the level of vibrations (vibration acceleration, vibration velocity, vibration displacement) of structural elements.
- **The weather station** is used to measure environmental parameters (wind strength and direction, air temperature and humidity, etc.).
- **Temperature sensors** are used to measure the temperature of certain components.



NAVIGATION RECEIVER



ANGLE SENSOR



STRAIN GAUGE



VIBRATION SENSOR



LINEAR SENSOR

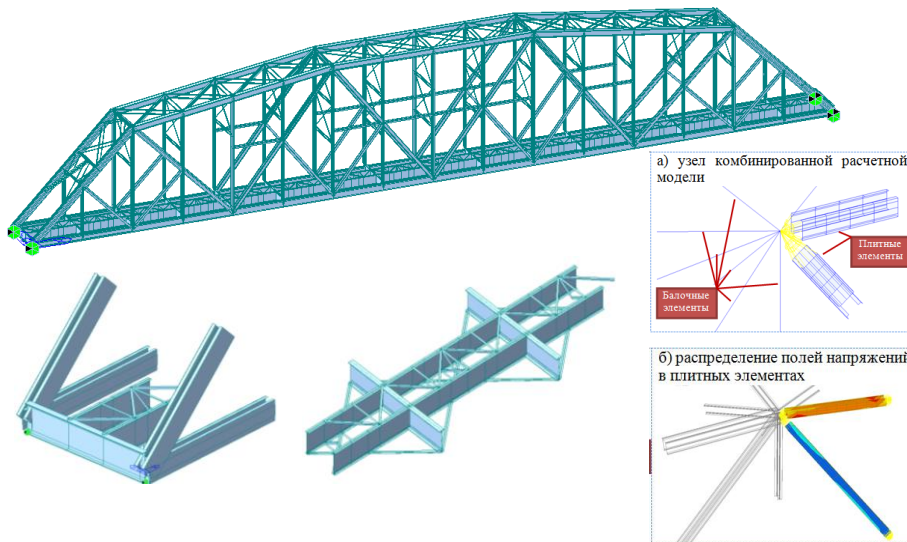


WEATHER STATION

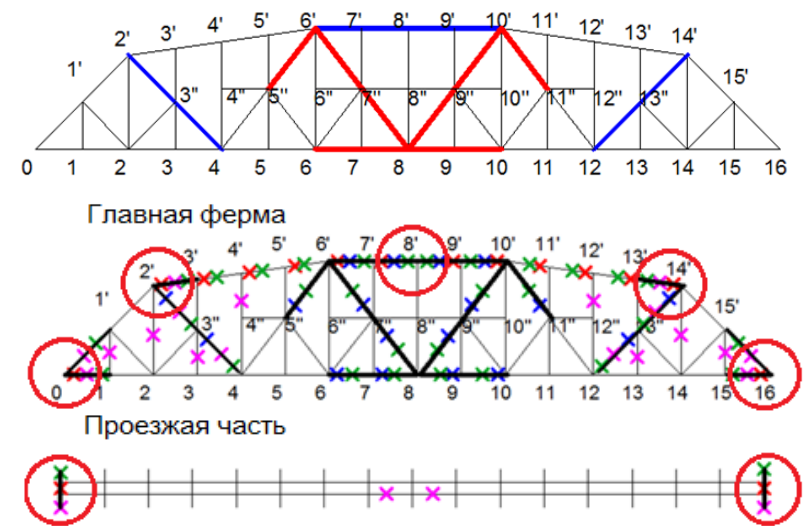
Development of a monitoring, analysis and predictive analytics system for a potentially dangerous railroad transport facility (3/4)

The main stages of development

- Development of a mathematical model of an object, taking into account the actual state of structural elements (building a digital twin).
- A comparative analysis of the limiting (threshold) values of the measured quantities with the values obtained from the results of mathematical modeling.
- Determination of the necessary and sufficient quantitative composition of control equipment (sensors) and determination of their location.



Fragments of the bridge span model

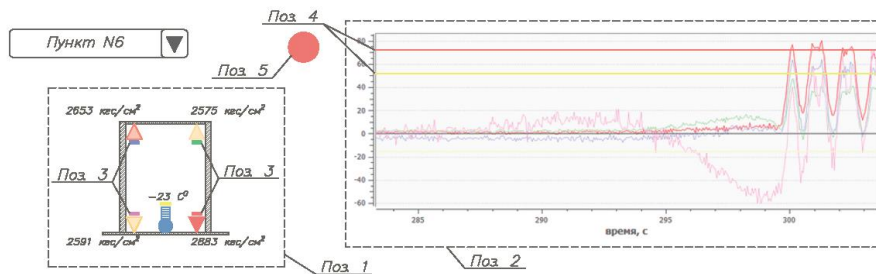


Scheme of the most loaded bridge spans

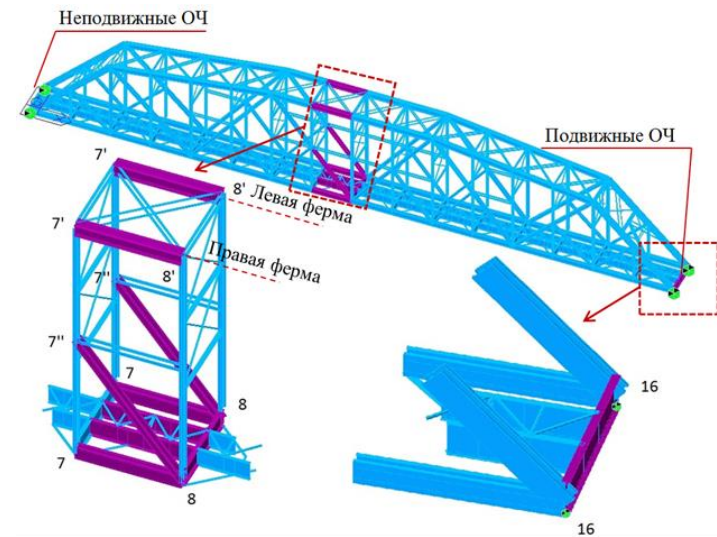
Development of a monitoring, analysis and predictive analytics system for a potentially dangerous railroad transport facility (4/4)

The main stages of development (cont.)

- Development of a technique for processing measurement data
- Development of a monitoring software package taking into account the information
- Predictive received software development



Processed information received from sensors



Fragments of the bridge span model

The main functions of software systems

- Collection, storage and processing of data.
- Transformations of values measured by indirect methods according to given formulas.
- Automated comparison of monitoring results with predetermined threshold values.
- Visualization and generation of reports on the technical condition of the monitored object.
- Information on changes in the technical condition of structures in the monitored object.