Multi-Disciplinarity in Science and Industry.

Emerging BIM Technologies

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What does multi-disciplinarity mean?

Inter-Disciplinarity

- Interdisciplinarity involves the combining of two or more academic disciplines into one activity (e.g., a research project). It is about creating something new by thinking across boundaries between traditional disciplines or schools of thought, as new needs and professions emerge. Large engineering teams are usually interdisciplinary, as an airport, power station or mobile phone or other project requires the melding of several specialties.

Trans-Disciplinarity

- Transdisciplinarity connotes a research strategy that crosses many disciplinary boundaries to create a holistic approach. It applies to research efforts focused on problems that cross the boundaries of two or more disciplines, and can refer to concepts or methods that were originally developed by one discipline, but are now used by several others. It merges natural sciences, applied sciences, social sciences and humanities to achieve a higher level of comprehension and awareness of the context where industrial products, processes, systems or services are experienced by users. New directions, like Cyber-Physical Systems (CPS), Internet of Things (IoT), human-centered design are part of that.

Synchro project team 2007-recent

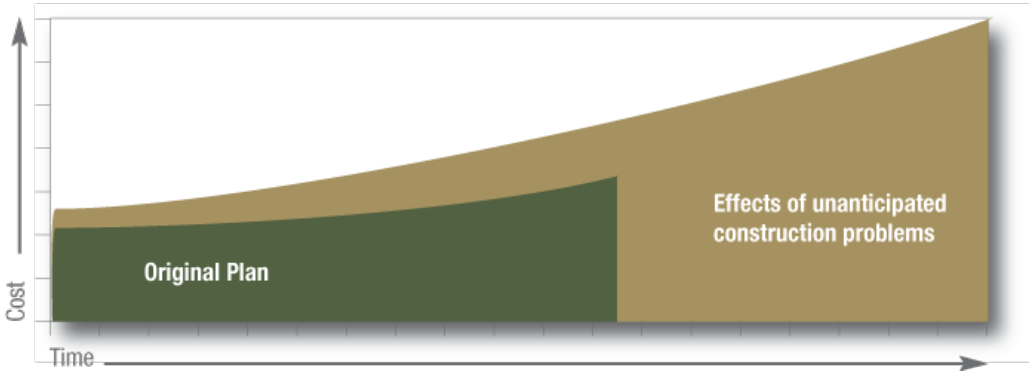
Disciplines

Information Modeling
Software Engineering
Spatio-Temporal Data Management
Distributed and Parallel Computing
Computer Graphics
Visualization
CAD/CAE/CAM
Computational Geometry
Scheduling
Project Management
Concurrent Engineering
System Integration

Project Planning and Management

Focus on certainty and productivity

- In general, complex industrial projects and programs are poorly predictable in delivery time, cost, and quality



Synchro

- Synchro Software Ltd. & ISP RAS since 2007
- Implements the concept of multi-disciplinarity (multi-D) and extends the planning capabilities of traditional project management systems
- Recognized by authoritative communities and awarded for innovations
- Currently used by more than 300 companies in 48 countries (not yet in Armenia)

Project Planning and Management

Traditional methods

- Critical Path Method (CPM) - 1943
- Program Evaluation and Review Technique (PERT) - 1958
- Critical Chain Method (CCM) - 1997
- Resource-Constrained (RCPSP) and Time-Constrained Project Scheduling Problem (TCPSP) -1983
- Earned Value Analysis (EVA) - 1967
- Visual tools: Gantt charts (1910), Network diagrams (Activity-On-Arc, Activity-On-Node), Line-Of-Balance Diagram (LOB), EVA plots, Resource Utilization plots

Popular project management systems

- MS Project
- Oracle Primavera
- Asta PowerProject
- Saprima
- Spider, Advanta, Gorizont ..

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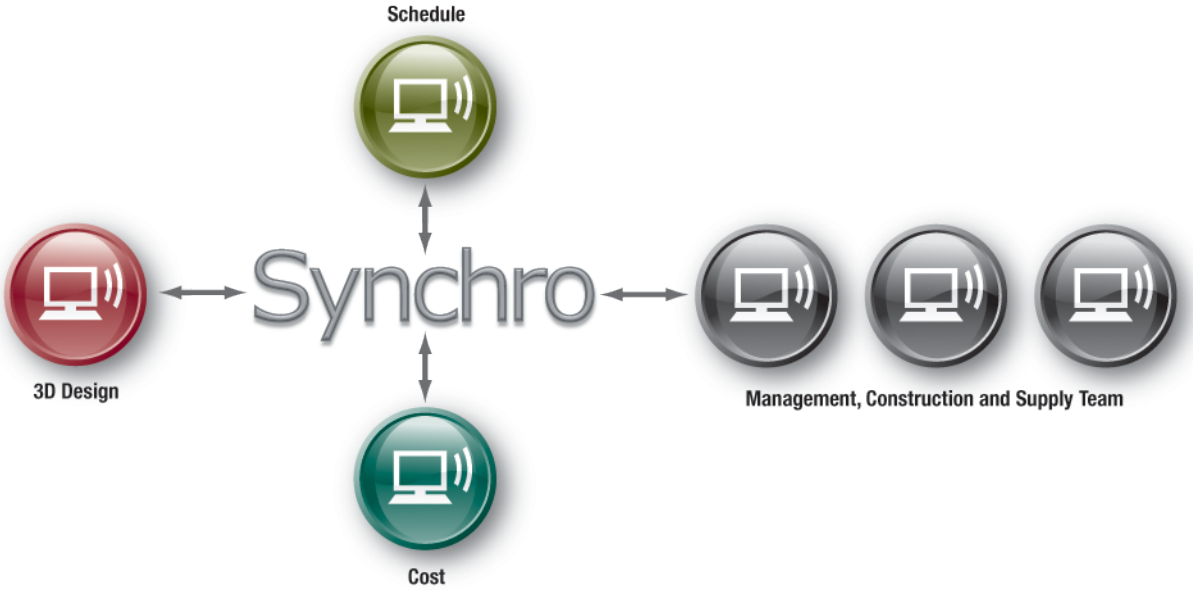
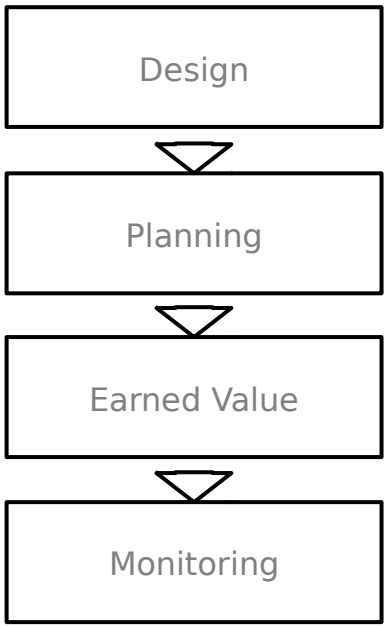
General principles

- **Multi-disciplinary** project analysis and simulation (5D)
- Consolidation of project data, schedules, costs (BIM)
- Multi-modal collaboration
- Multi-configurations (standalone, client-server, OODB, mobile, clouds,..)
- Integration with third-party systems (3D CAD, PM,..)





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Functionality

- Advanced planning and scheduling
- Spatio-temporal verification of schedules
- Visual analysis of alternative baselines
- Visual earned value analysis
- Visual resource leveling
- Report generation using series of documents, images, videos

Advantages

- Improved communication and interpretation among project stakeholders
- Effective coordination of works
- Trustworthy and robust project schedules
- Visual monitoring and decision making
- Reduced risks, costs, delivery time

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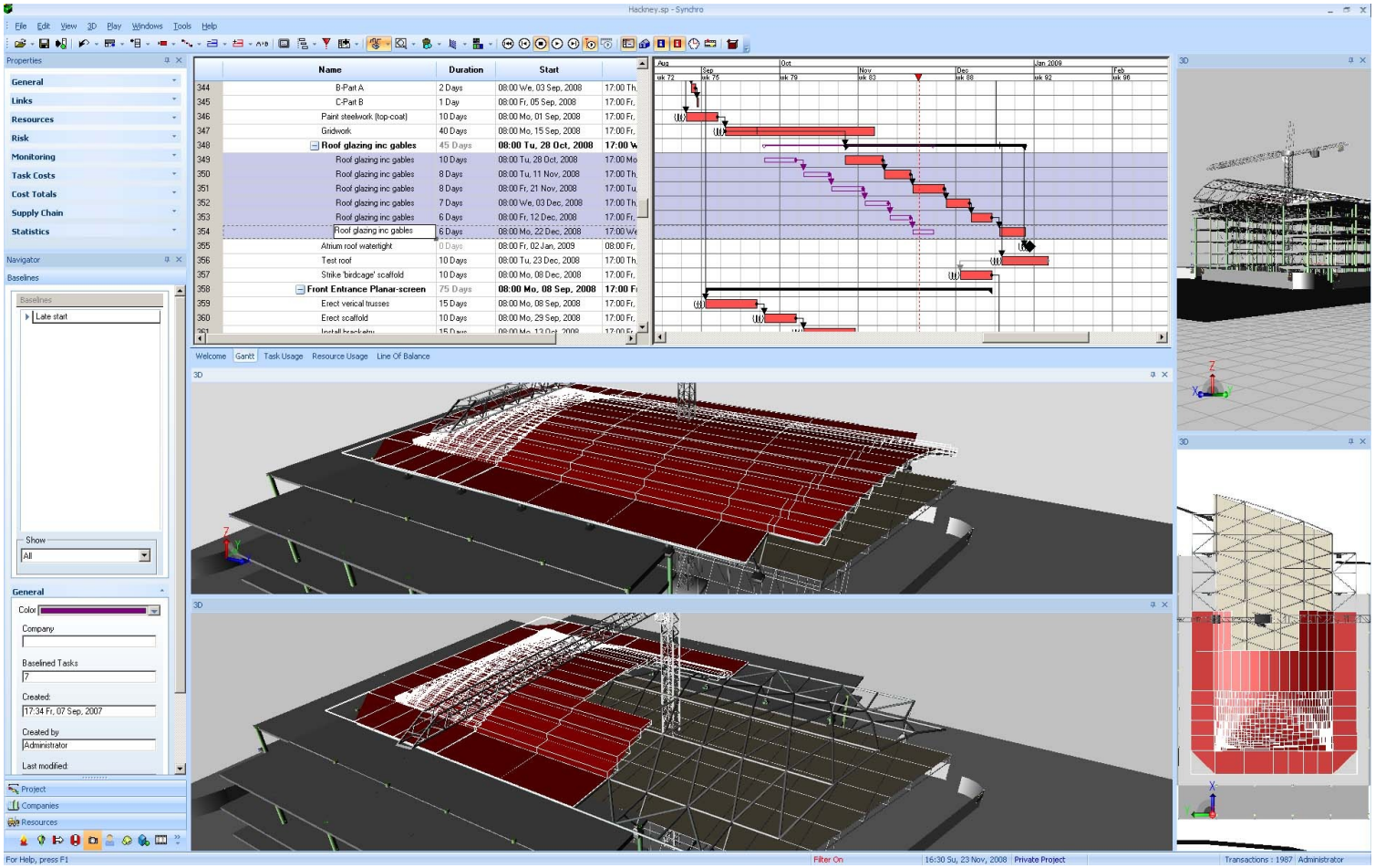
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Strike 'birdcage' scaffold
Front Entrance Planar-screen
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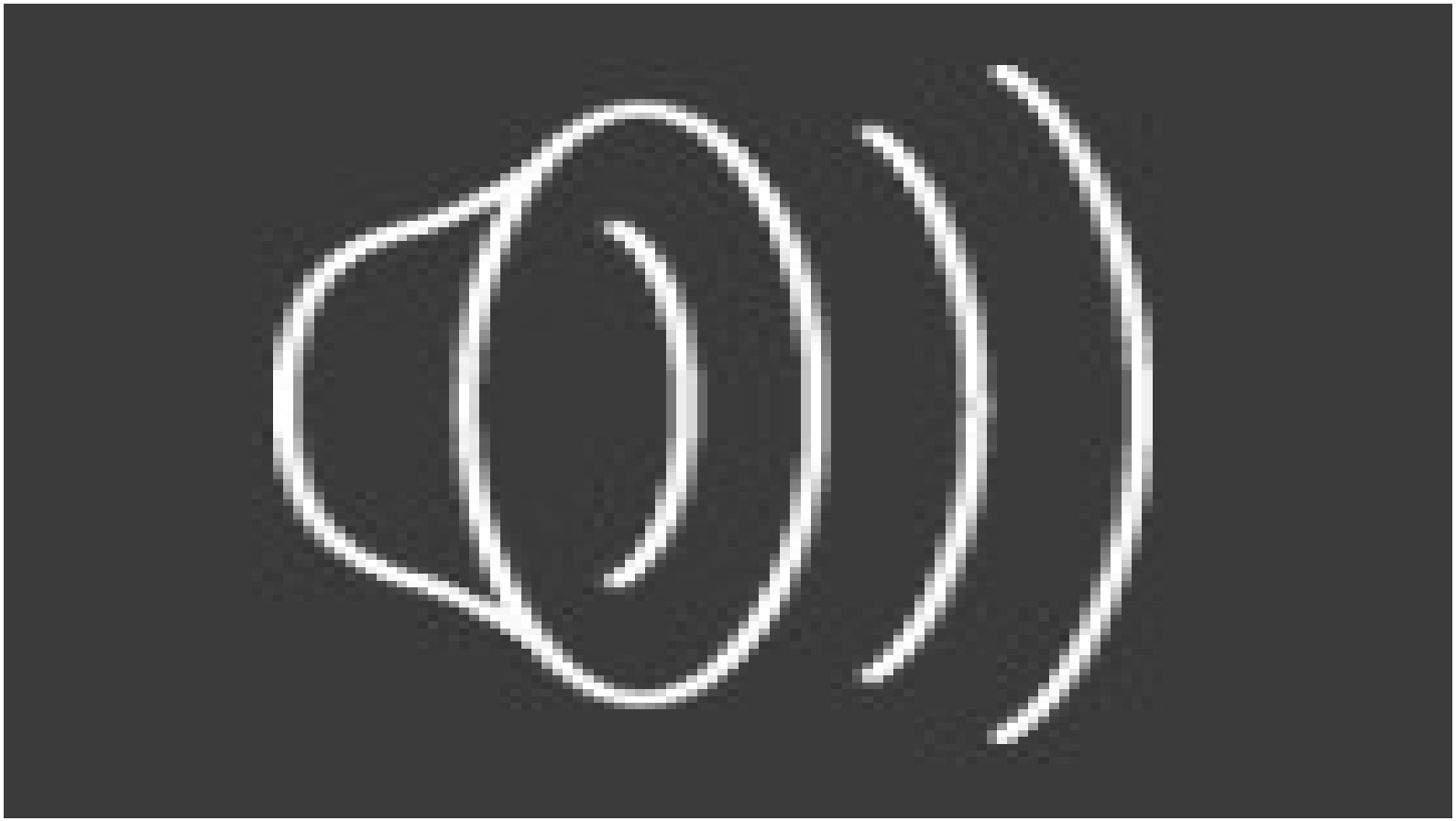

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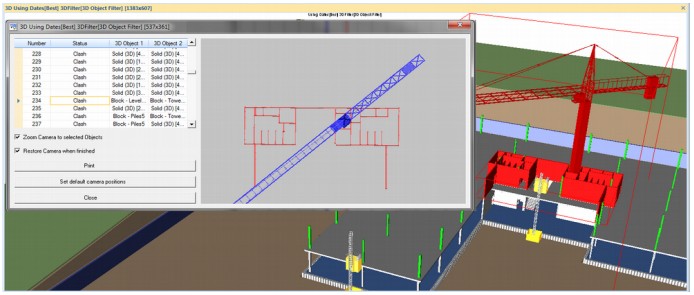
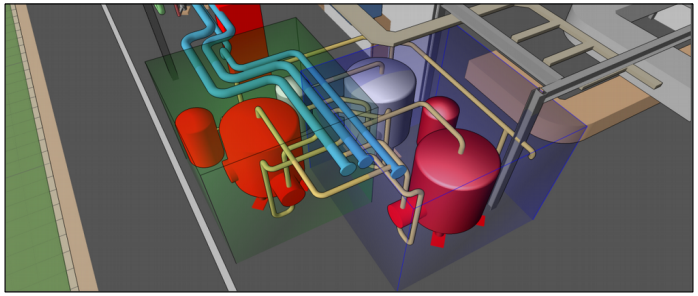
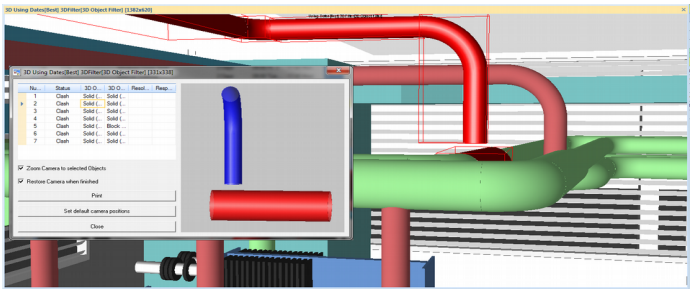
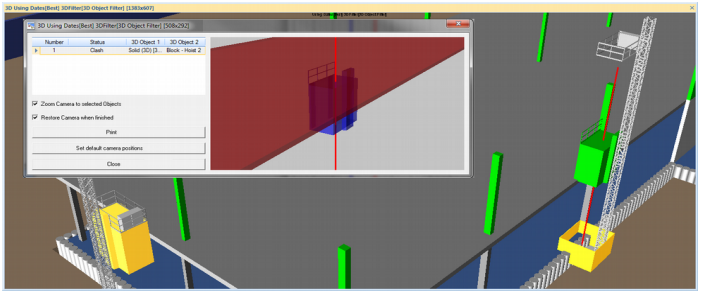
Spatio-temporal verification

- Clashes and interferences
- Installation (removal) before (after) supporting or fastening elements
- Workspaces overlapping or congesting
- Inability to deliver elements to destinations along conflict-free paths









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Scheduling Problems

(1) CPM $\min t_N$

(2) $t_{S(m)} \geq t_{P(m)} + d_{P(m)} + dl_m, \quad \forall m = 1,\ldots,M$

(3) RCPSP (NP-hard) $\sum_{n \in A(t)} u_{nk} \leq U_k, \quad \forall k = 1,\ldots K, \quad \forall t \mid t_1 \leq t \leq t_n$

$s_{l'}(t) \cap s_{l''}(t) = \varnothing, \ \forall l', l'' \in D(t), l' \neq l'', \forall t \in [t_1, t_n]$

(4) GCRSP (PSpace-hard) $\forall l' = 1,\ldots,L, l' \in D(t), \ \forall t \geq t_1 \rightarrow$

(5) (clashes) $\exists k'' = 1,\ldots,K, \exists k \leq E \mid T^e(s_{l'}(t)) \cap s_{l''}(t) \neq \varnothing$

$\forall (n,k) \in I(n,k) \quad \forall t \in [t_n, t_n + d_n)$

(6) $\sum_{(n',k') \in I(A,U)} u_{n'k'} \frac{v_{k'}}{v(w_{i(n',k')})} v(w_{i(n,k)}(t) \cap w_{i(n',k')}(t)) \leq v(w_{i(n,k)})$

$\forall l = 1,\ldots,L, \quad \forall a_{n,m} \leftrightarrow s_l$

(7) $\exists P(\tau) \mid P(0) = p(t_{n,m-1} + d_{n,m-1}), P(1) = p(t_{n,m}), s_l(P(\tau)) \cap s_{l'}(t_{n,m}) = \varnothing, \ \forall l' \neq l, \ \forall \tau \in [0,1]$

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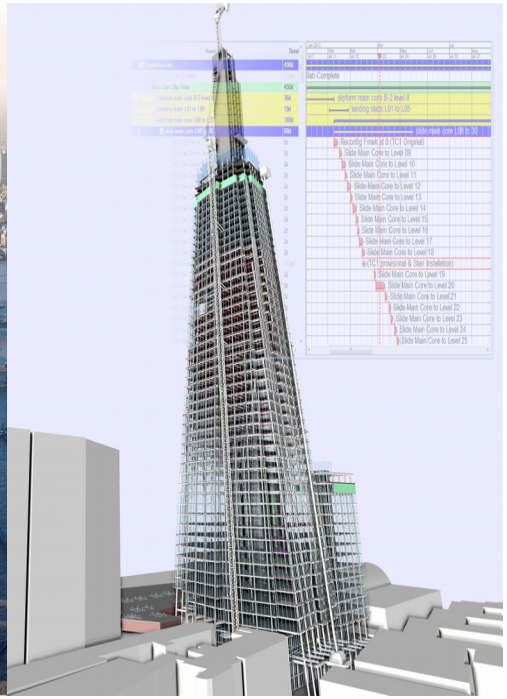

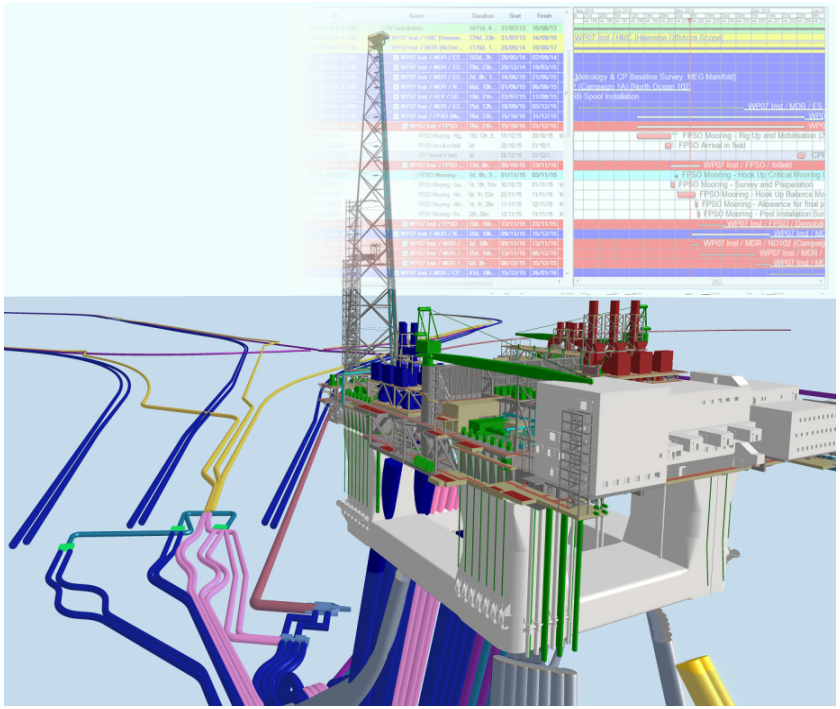

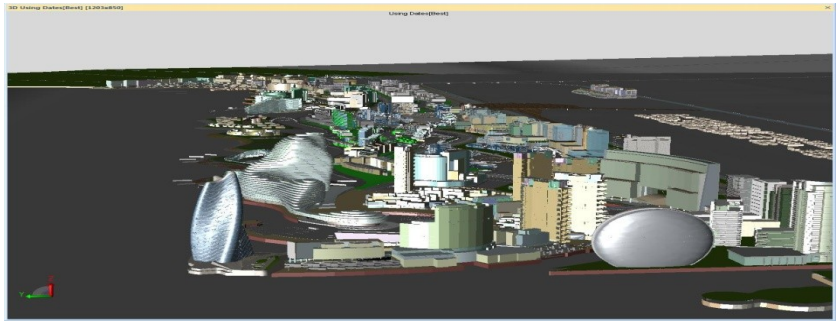

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Some industrial projects

- Wembley reconstruction, Summer Olympics 2012, Costain plc
- Skyscraper "Shard of Glass", London, MACE
- Integrated development of Al Rai coast, UAE, ALDAR / Laing O'Rourke
- Sacramento International Airport, USA, Turner Construction Company
- Cardiovascular Medicine Center, San Francisco, USA, Rudolph and Sletten
- NPP, USA, Power Construction Company, LLC
- State Clinic, Anaheim, California, USA, Hensel Phelps Construction Co.
- HPP, Wuskvatim, California, USA, Manitoba Hydro
- Oil and gas platforms, Brazil, Petrobras

- Beloyarsk NPP, Russia, Research Institute OrgenergoStroy
- Kursk NPP, Russia, NIKIMT-Atomstroy
- Pokrovskaya complex gas processing plant, Russia , Orenburgneft
- Reconstruction of Abakan airport, Russia, Administration of civil airports
- Multifunctional radiochemical research plant, Russia, JSC SRC

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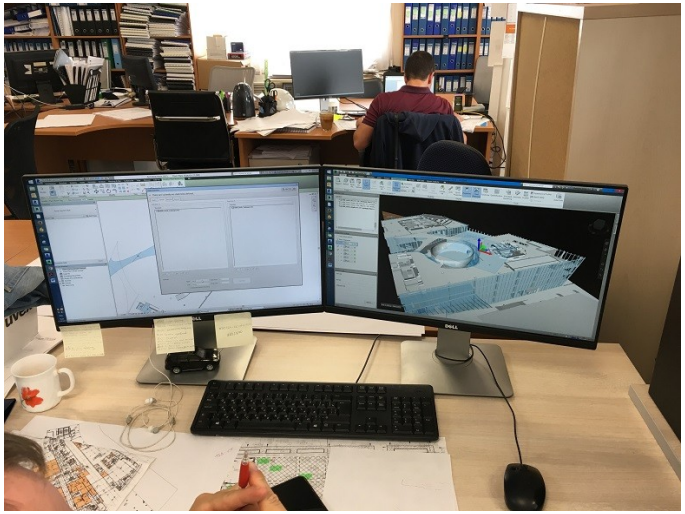
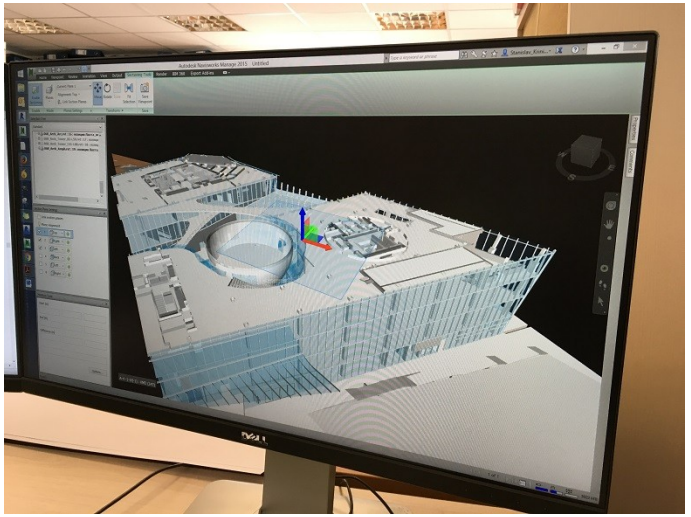
Lakhta centre, Saint-Petersburg, 2012-2018

Highest in Russia and Europe (462 m)

87 stages (378 m)

Area 400000 m*2





Thank for attention

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