

# **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

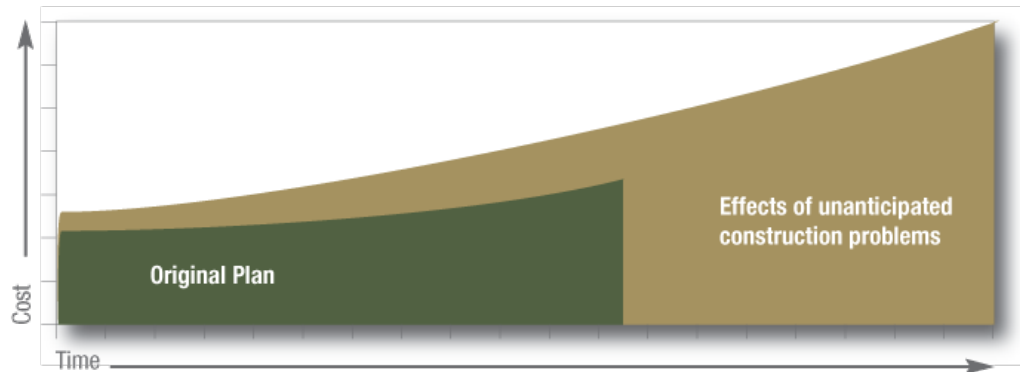
Information Modeling  
Software Engineering  
Spatio-Temporal Data  
Management  
Distributed and Parallel  
Computing  
Computer Graphics  
Visualization  
CAD/CAE/CAM  
Computational Geometry  
Scheduling  
Project Management  
Concurrent Engineering  
System Integration



# 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

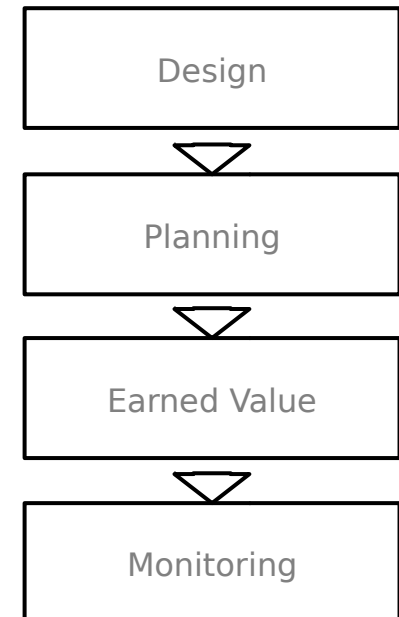
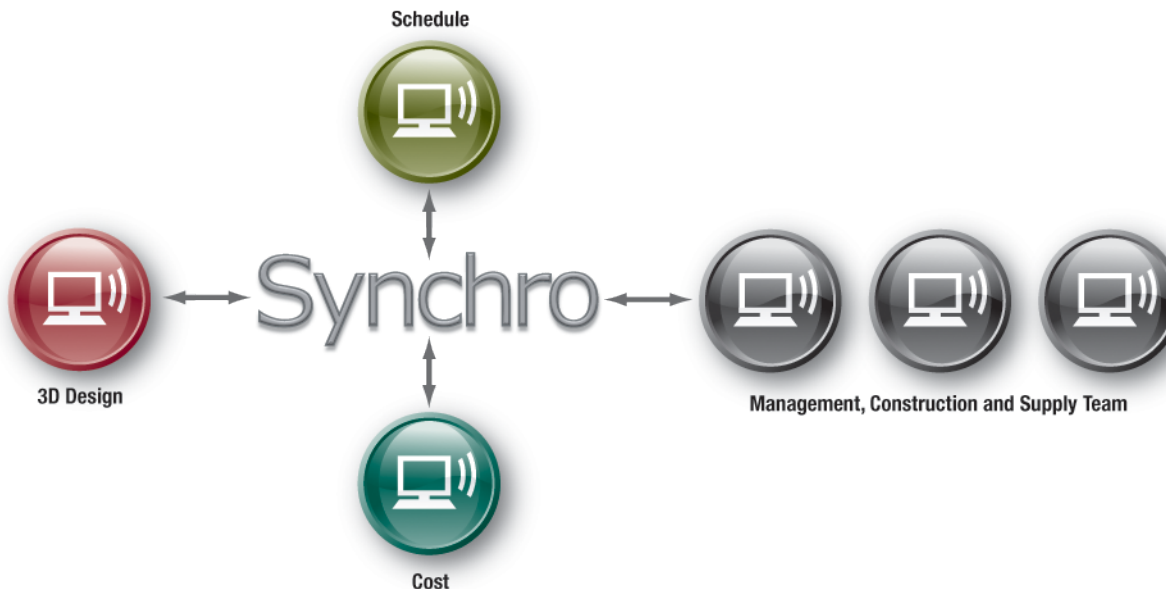
## Popular project management systems

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

# Synchro

## 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,..)



# Synchro

## **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

# Synchro

The screenshot displays the Synchro software interface, which is used for project management and construction simulation. The main window is titled 'Hackney.sp - Synchro' and features a menu bar (File, Edit, View, 3D, Play, Windows, Tools, Help) and a toolbar with various icons for navigation and editing.

On the left side, there are several panels:
 

- Properties:** A tree view showing categories like General, Links, Resources, Risk, Monitoring, Task Costs, Cost Totals, Supply Chain, and Statistics.
- Navigator:** A panel showing the project hierarchy, including a 'Baselines' section with a 'Late start' baseline.
- General:** A panel with fields for 'Color', 'Company', 'Baselined Tasks' (containing '7'), 'Created' (17:34 Fr, 07 Sep, 2007), 'Created by' (Administrator), and 'Last modified'.
- Project:** A panel showing 'Companies' and 'Resources'.

The central area is divided into two main views:
 

- Gantt Chart:** A task list on the left and a Gantt chart on the right. The task list includes:
 

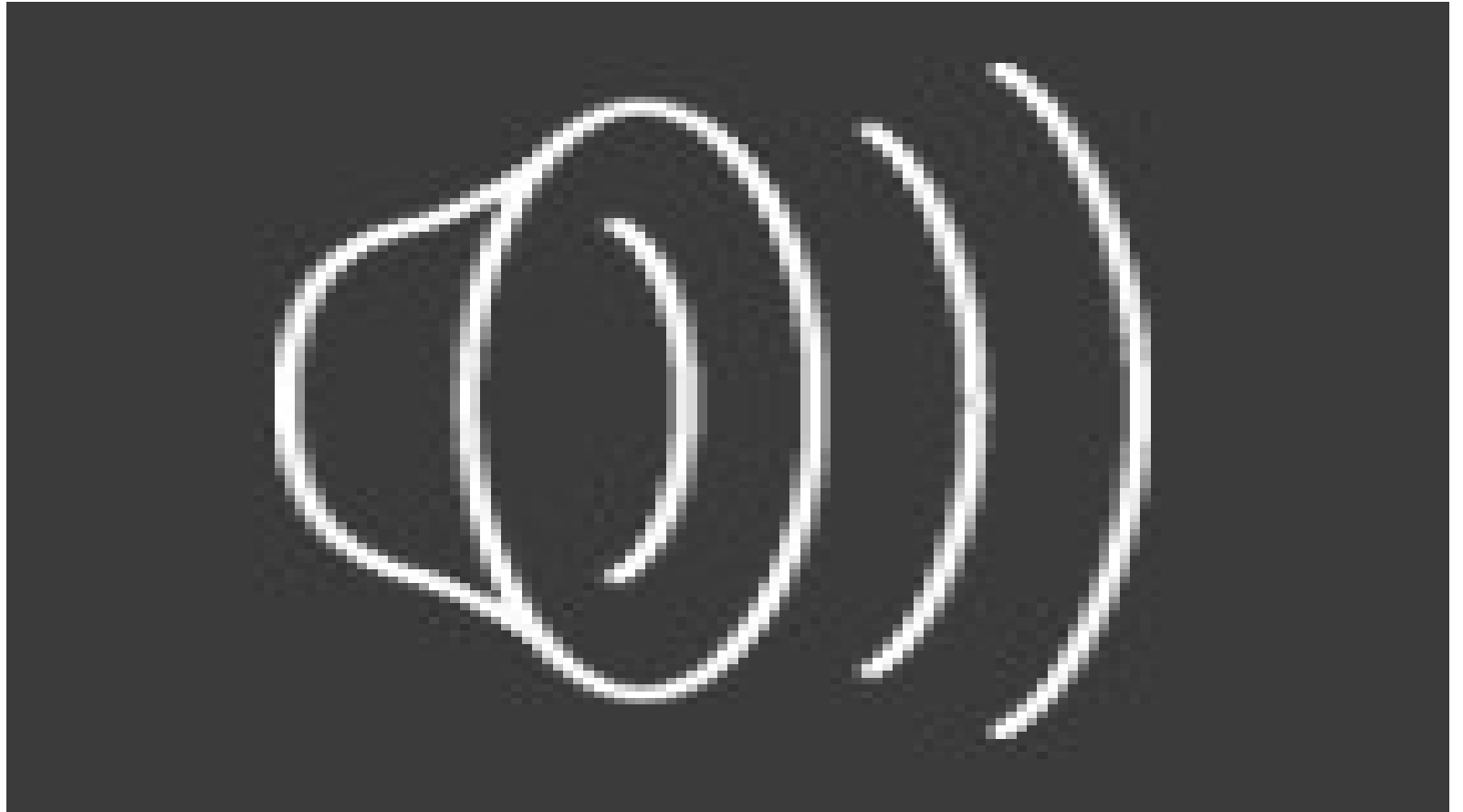
ID	Name	Duration	Start	End
344	B-Part A	2 Days	08:00 We, 03 Sep, 2008	17:00 Th
345	C-Part B	1 Day	08:00 Fr, 05 Sep, 2008	17:00 Fr
346	Paint steelwork (top-coat)	10 Days	08:00 Mo, 01 Sep, 2008	17:00 Fr
347	Girdwork	40 Days	08:00 Mo, 15 Sep, 2008	17:00 Fr
348	<b>Roof glazing inc gables</b>	45 Days	<b>08:00 Tu, 29 Oct, 2008</b>	<b>17:00 We</b>
349	Roof glazing inc gables	10 Days	08:00 Tu, 29 Oct, 2008	17:00 We
350	Roof glazing inc gables	9 Days	08:00 Tu, 11 Nov, 2008	17:00 Th
351	Roof glazing inc gables	9 Days	08:00 Fr, 21 Nov, 2008	17:00 Tu
352	Roof glazing inc gables	7 Days	08:00 We, 03 Dec, 2008	17:00 Th
353	Roof glazing inc gables	6 Days	08:00 Fr, 12 Dec, 2008	17:00 Fr
354	Roof glazing inc gables	6 Days	08:00 Mo, 22 Dec, 2008	17:00 We
355	Attum roof watertight	1 Day	08:00 Fr, 02 Jan, 2009	08:00 Fr
356	Test roof	10 Days	08:00 Tu, 22 Dec, 2008	17:00 Th
357	Stake birdcage/ scaffold	10 Days	08:00 Mo, 08 Dec, 2008	17:00 Fr
358	<b>Front Entrance Planar-screen</b>	75 Days	<b>08:00 Mo, 08 Sep, 2008</b>	<b>17:00 Fr</b>
359	Erect vertical trusses	15 Days	08:00 Mo, 08 Sep, 2008	17:00 Fr
360	Erect scaffold	10 Days	08:00 Mo, 29 Sep, 2008	17:00 Fr
361	Install birdcage	15 Days	08:00 Mo, 13 Oct, 2008	17:00 Fr
- 3D View:** A 3D rendering of a building under construction, showing the steel framework and the roof structure. The roof is highlighted in red, corresponding to the 'Roof glazing inc gables' task in the Gantt chart. The view is labeled '3D' in the top-left corner.

At the bottom of the window, there is a status bar with the following information:
 

- File: On
- 16:30 Su, 23 Nov, 2008
- Private Project
- Transactions: 1987
- Administrator



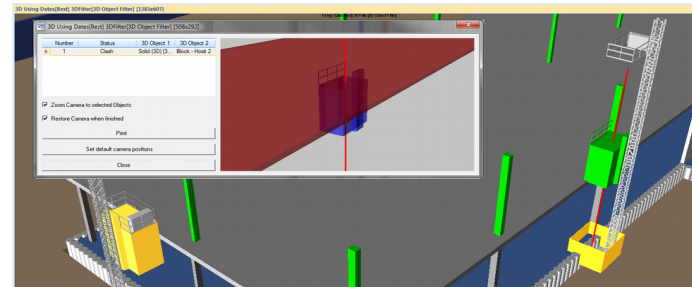
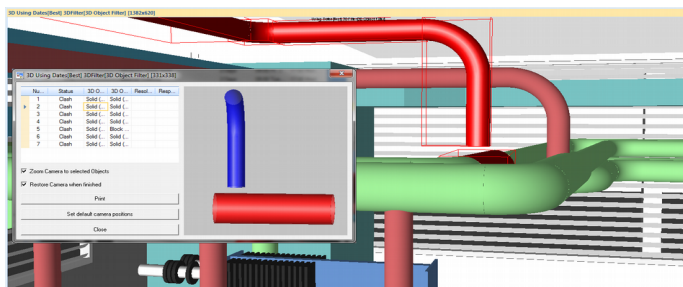
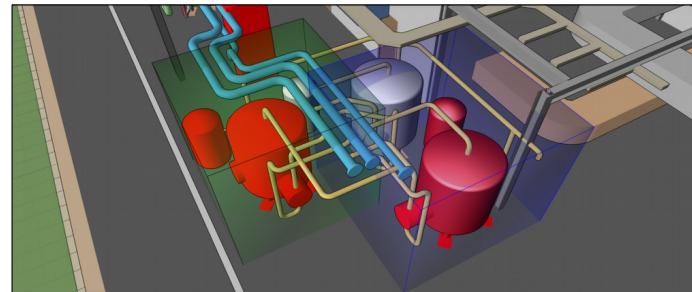
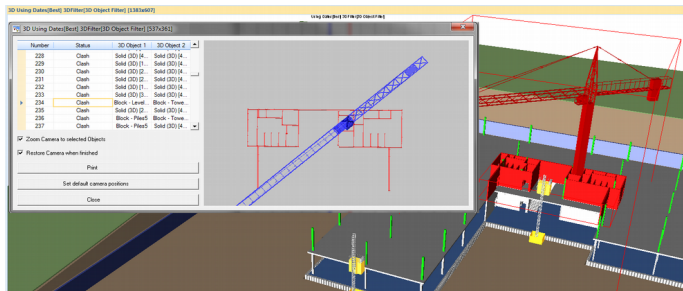
# Synchro



# Synchro

## 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



# Synchro

## Scheduling Problems

(1) CPM  $\min t_N$

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

(3) RCPSP (NP-hard)  $\sum_{h \in A(t)} u_{h,k} \leq U_k, \quad \forall k = 1, \dots, K, \quad \forall t | t_1 \leq t \leq t_n$

$$s_{I^{\square}}(t) \cap s_{I^{\boxplus}}(t) = \emptyset, \quad \forall I^{\square}, I^{\boxplus} \in D(t), I^{\square} \neq I^{\boxplus}, \quad \forall t \in [t_1, t_n]$$

(4) GCRSP (PSPACE-hard)  $\forall l = 1, \dots, L, I \in D(t), \quad \forall t \geq t_1 \rightarrow$

(5) (clashed joins, work spaces, spots)  $s_{I^{\boxplus}}(t) \neq \emptyset$

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

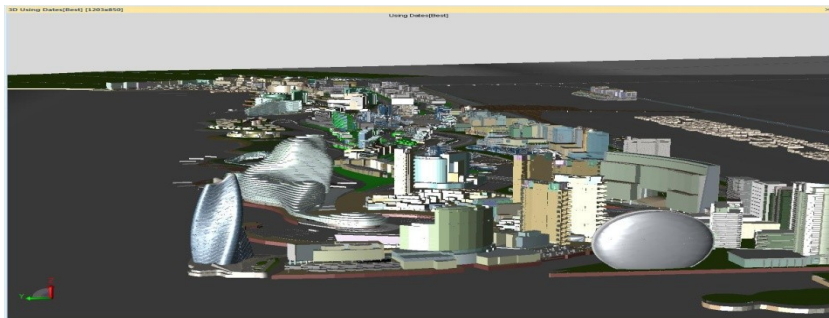
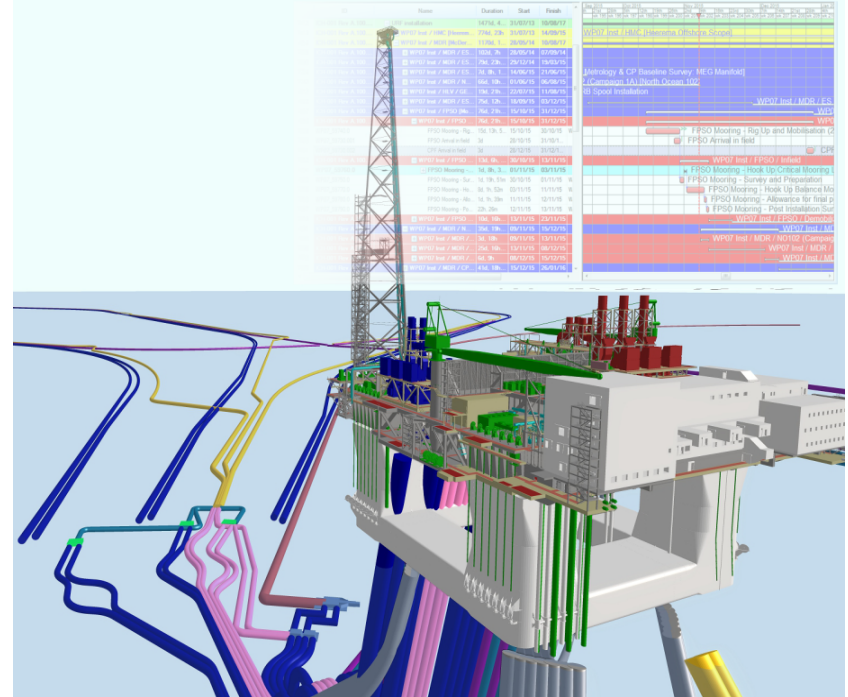
(6)  $\sum_{(n^{\square}, k^{\square}) \in I(A, U)} u_{n^{\square}, k^{\square}} \frac{v_{k^{\square}}}{v(w_{i^{\square}(n^{\square}, k^{\square})})} v(w_{i^{\square}(n, k)}(t) \cap w_{i^{\square}(n^{\square}, k^{\square})}(t)) \leq v(w_{i(n, k)})$

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

$$\exists P(\tau) | P(0) = p(t_{n, m-1} + d_{n, m-1}), P(1) = p(t_{n, m}), s_l(P(\tau)) \cap s_{I^{\square}}(t_{n, m}) = \emptyset, \quad \forall I^{\square} \neq l, \quad \forall \tau \in [0, 1]$$

(7)

# Synchro



# Synchro

## **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

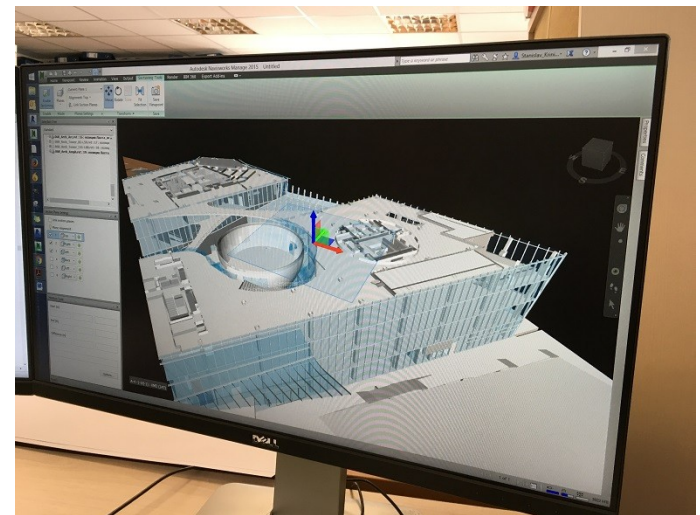
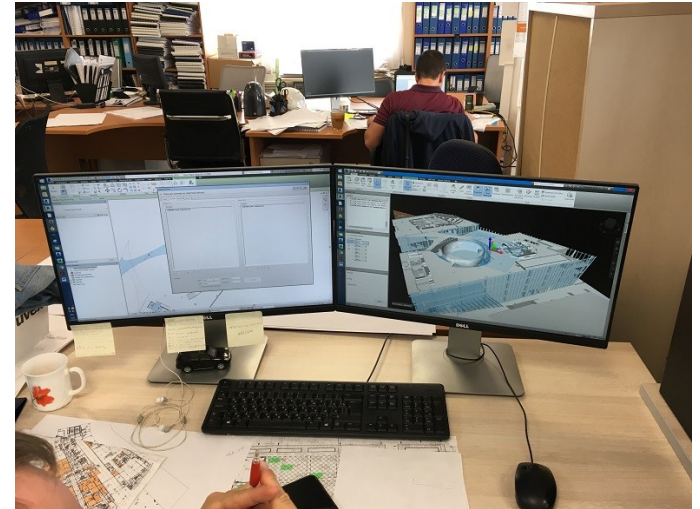
# Synchro

**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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