

Solution: IBM ILOG CPLEX Optimization Studio – Constraint Programming

Industry: Mining

ESAN – Mining Company

With a 92 km long tunnel network and a depth of 836 meters, ESAN Balya is Turkey's deepest lead and zinc mine.

The mining operations at Balya is carried out by a fleet of mobile machinery and transportation vehicles. The extraction plans are made to meet weekly production targets. The planner's job is to schedule a production cycle, consisting of activities of uncertain durations, with each activity using different mobile machinery from a limited fleet size. The transportation of excavated earth is done by large trucks which share the single-way winding underground road, with the mobile mining machineries.

Business challenge & planning needs

ESAN Mining operates Turkey's deepest lead and zinc mine in Turkey, featuring an extensive underground network (exceeding 90 km of tunnels) and round-the-clock production. The primary challenge was to create efficient short-term schedules for multiple, interdependent tasks (e.g., drilling, blasting, hauling) executed by a limited fleet of specialized equipment.

Single-lane underground roads, real-time disruptions (equipment breakdowns or unexpected delays), and varying task durations further complicated scheduling. ESAN needed a robust, data-driven solution that could:

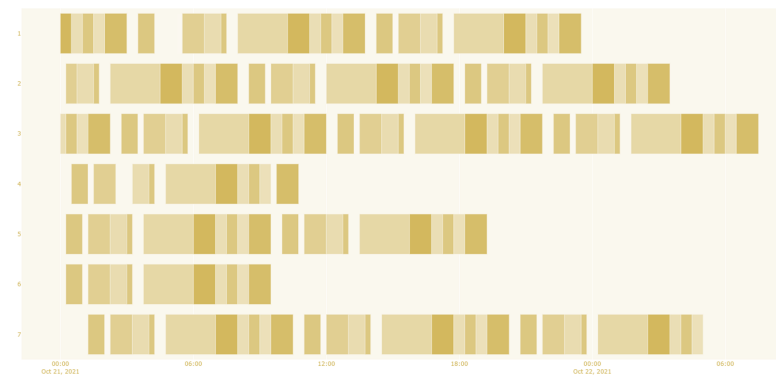
- Integrate live operational data (location & status)
- Comply with HSE standards (e.g., blast exclusion zones).
- Automatically re-optimize schedules in near-real time when operational conditions changed.
- Provide scenario modeling (different production targets, changing resource availability) to support strategic decisions.



Solution

Constraint Programming approach was implemented using IBM ILOG CPLEX Optimization and then integrated to ESAN's MES system. Key aspects of the solution include:

- Real-Time Data Integration: Tapping into underground tracking to pull equipment location, task progress, and breakdown events
- Advanced Scheduling Model: Mapping each mining face with a required sequence of tasks and constraints (blasting windows, multi-step cycles, travel times, and equipment availability)
- Scenario Analysis & Rapid Re-Optimization: Generating alternative schedules within minutes whenever conditions (e.g., a breakdown or updated priorities) changed
- User-Friendly Interfaces: Automatic assignment results and notifications were delivered to field vehicle tablets and dispatch operators, ensuring quick actions



Results

- 15% Reduction in Cycle Time: The optimized scheduling model reduced the overall time per face cycle by minimizing idle periods and travel conflicts.
- Improved Resource Utilization: Idle equipment time (outside of scheduled maintenance) was nearly eliminated, and production targets were systematically met.
- Agile & Responsive Planning: The ability to run new scenarios in under five minutes empowered planners to adapt to real-time disruptions.
- Enhanced Data Practices: The project spotlighted data-quality issues and drove improvements in data capture, validation, and operational reporting.

Benefits

The optimization-based scheduling solution empowered ESAN Balya to shorten cycle times, improve equipment utilization, and maintain robust control over a complex underground mining operation:

- Higher Production Efficiency: Meeting or surpassing weekly tonnage goals with fewer bottlenecks.
- Stronger Operational Control: Real-time insights and fast re-optimization enabled immediate corrective actions, ensuring 100% adherence to mandatory tasks.
- Positive ROI & Scalability: The solution can be extended to additional sites and integrated with future automation initiatives, extending the proven EBITDA increases across the whole operations

ESAN is a prominent Turkish mining and industrial raw materials company, known for its innovative range of products.



Project Scope

► Optimization-Based Operational Scheduling Solution

- Resolution of the best equipment-task-location assignment within minutes
- Transfer of assignments to field vehicle screens and handheld tablets with live data integration
- Mine operation planning broken down by month, week, and shift
- Strategic decision support through scenario creation
- Optimized shift planning
- Real-time creation of the best alternative schedule at operation disruptions

Project Deliverables & Values

► Real-Time Mine Operations Optimization

- Minimization of cycle time per task
- Maximization of weekly extracted tonnage
- Maximization of equipment utilization rate
- Support for HSE compliance with blasting distance and heavy equipment operation constraints

► Value

- 15% shorter completion time for mine task cycles
- 100% adherence to mandatory tasks in the weekly plan
- Elimination of idle equipment time outside of maintenance and breakdowns





MINE SCHEDULING
OPTIMIZATION

CPLEX-JAVA
REAL-TIME OPERATIONAL DATA
INTEGRATION

2 km Depth
+100 km Corridors
7/24 Operation

1,200,000
tons / year
PRODUCTION
CAPACITY



RIGHT

INTEGRATED PLANNING



PLACE
TASK
TIME
RESOURCE

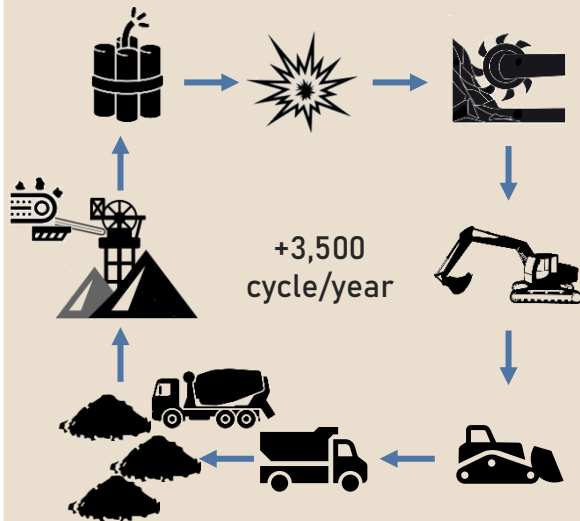


HIDDEN
OPPORTUNITIES
ORE TONNAGE MAXIMIZATION



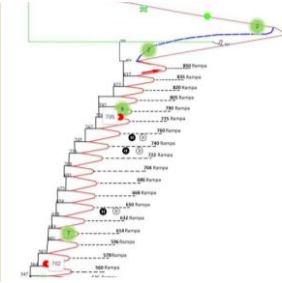
FAST & RELIABLE

SCENARIO ANALYSIS



LIVE
FIELD
INTEGRATION

+100 Vehicles and
Teams
+10 Distinct Tasks



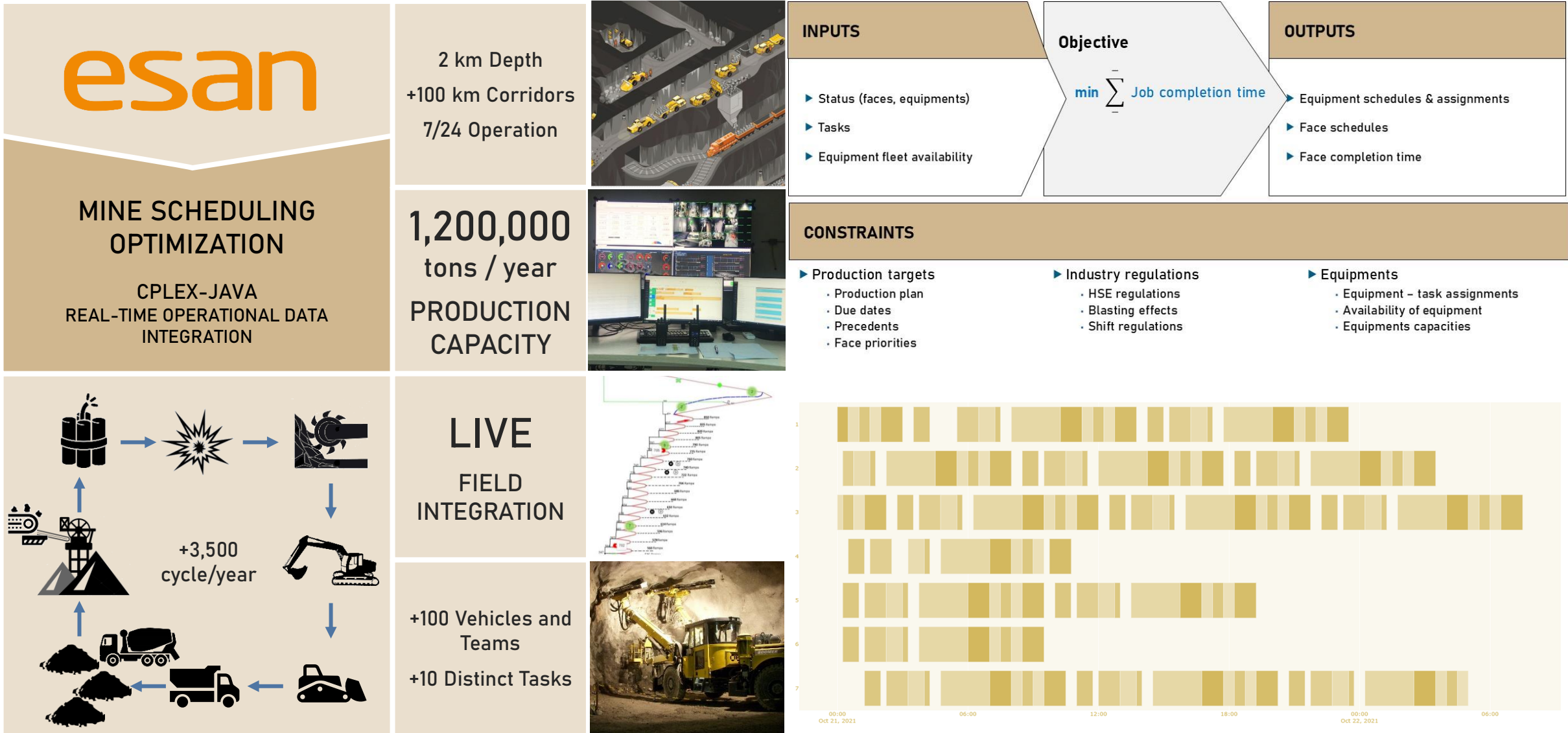
REAL TIME
OPTIMIZATION



< 5 mins

OPTIMIZATION RUN TIME

Scheduling Optimization of Underground Mines





IBM ILOG CPLEX Optimization Studio is a consolidation of the OPL integrated development environment and the CPLEX and CP Optimizer solution engines in a single product. CPLEX Optimization Studio provides the fastest way to build efficient optimization models and state-of-the-art applications for the full range of planning and scheduling problems. With its integrated development environment, descriptive modeling language and built-in tools, it supports the entire model development process. CPLEX, a feature of IBM ILOG Optimization Studio, offers state of the art performance and robustness in an optimization engine for solving problems expressed as mathematical programming models. © Copyright IBM Corporation 2020. IBM logo is a trademark of International Business Machines Corp
GRAT

SELCO Consulting is a recognized consulting company with distinguished capabilities in supply chain and logistics management, delivering outstanding results and helping clients to use their resources more effectively by combining leading information technology and advanced analytics.

Our culture based on integrity and diligent effort, coupled with exceptional passion for delivering results enable us to retain and develop our customer base across all major industries and service sectors. Our partners around the globe with unique knowhow clusters accelerate and enhance the value of our services.

We provide consulting services for

- Supply Chain Transformation
- Business Analytics
- Advanced Planning Software Implementation
- Factory & DC Design

We are a team, always proud to do the right by our clients, our partners, and our communities.

Excellence is not a single act, but a habit